IALA GUIDELINES

ON THE

UNIVERSAL AUTOMATIC IDENTIFICATION SYSTEM

(AIS)

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FOREWORD

IALA'S ROLE IN THE DEVELOPMENT OF AIS STANDARDS

The International Association of Marine Aids to Navigation and Lighthouse Authorities (IALA) has been the primary organisation sponsoring and co-ordinating the development of the Automatic Identification System (AIS). In 1996, the Vessel Traffic Services (VTS) and Radionavigation Committees of IALA prepared a draft recommendation that, with further refinement within IMO NAV, became the basis for the IMO Performance Standard on AIS.

In October 1997, at the request of several emerging AIS equipment manufacturers, IALA hosted a working group of manufacturers and maritime administrations to agree on a standard technology for AIS stations. The group, which was formally designated the IALA AIS Working Group, completed a draft recommendation, which was submitted by Sweden, on behalf of Finland, Germany, Canada, South Africa, and the United States to the International Telecommunications Union – Sector for Radiocommunications (ITU-R).

Renamed the IALA AIS Steering Group, this body met twice yearly under the IALA umbrella to continue the development of system standards and applications as well as the development of these "*IALA Guidelines on Ship-borne Automatic Identification System (AIS)",* a significant project in itself. In December 1999 the IALA Council agreed that, in view of the international significance of the implementation of AIS, the Steering Group should become the AIS Committee of IALA.

1 PREFACE

1.1 INTRODUCTION

It has long been realised that an automatic reporting device fitted to a vessel would benefit the safety of navigation and integrity of the marine environment. With past decades' advent of technology providing increased positional accuracy and rapidity of data exchange, a system that exploits DGPS – enhanced autonomous transponder techniques, has become both technologically feasible and economically viable.

The Automatic Identification System (AIS) is defined in section 2.1. The introduction of AIS technology is described in section 1.3, with Authorities, world wide, in full recognition of the potential of AIS to go beyond safety and marine environmental protection, to exercise a monitor/control function, and possibly serve as a means of accountability for heightened maritime security.

AIS Guidelines have been prepared for IALA members, particularly the Authorities, as standards and functions evolve. The maritime industry as a whole is in need of this same reference that educates, orients, and facilitates as AIS is implemented.

The AIS journey has just begun, but IALA AIS Guidelines version 1.0 (Dec 2001) is already superseded by this version (1.1), with substantial amounts of new information and a reorganisation of format. Subsequent versions will benefit from continuing technological advances and lessons-learned from implementation. Users are welcome to join the process and contribute to Guideline content, communicating via the IALA web site (www.iala-aism.org).

Any version of IALA AIS Guidelines is a snapshot of the present state-of-play. Attempts are made throughout, however, to project the future. AIS Guidelines will remain a dynamic document, subject to as frequent a revision as issue-urgency dictates. Every projection will then be evaluated for transformation into guidance, to ensure Guideline relevance as a document of both policy and process.

1.2 PURPOSE

IALA AIS Guidelines provide a one-stop clearing-house for both operational and technical aspects of AIS, over an increasingly wider range of shore-based applications. Such guidance should serve as inspiration and motivation to make full use of AIS, achieving efficiency and effectiveness, and supporting maritime productivity. This guidance keeps ship-ship safety as its primary objective.

The purpose of Volume 1 Part 1 is operational guidance, written from the users' point of view who will employ AIS as a tool. The spectrum of use ranges from Competent Authorities through Officers of the Watch (OOW), pilots, VTS Operators, managers and students.

The purpose of Volume 1 Part 2 is technical guidance and description, including ship-borne and shore-based devices e.g., Vessel Traffic Services (VTS), Ship Reporting Systems (SRS) and Aids to Navigation (AtoN). This part does not intend to compete with proper technical manuals needed for system design, installation or maintenance.

1.3 BACKGROUND

This section describes the international requirements and the process that enabled AIS to become a shipboard carriage requirement under the revised IMO Safety of Life at Sea Convention 1974 SOLAS 74 which is applicable to ships from 300 gross tons and upwards. It also explains the basis for carriage by ships not covered by SOLAS 74 (e.g., fishing vessels and pleasure craft) and as an Aid to Navigation device, which would enhance the current service provided by Lighthouse Authorities.

1.4 INTERNATIONAL MARITIME ORGANISATION (IMO) PERFORMANCE STANDARD

The main interest of IMO can be summed up in the phrase *safer shipping and cleaner oceans.* One of the most important IMO conventions is the International Convention for the Safety of Life at Sea 1974, better known as SOLAS.

An initiative to introduce the carriage of AIS as a SOLAS requirement was made by the International Association of Marine Aids to Navigation and Lighthouse Authorities during the early 1990's, using the proposed Global Maritime Distress and Safety System (GMDSS) that had already been approved and was being implemented. The proposed system was primarily intended to identify ships and the ships position in VTS area of coverage and in areas of restricted waters. The system used the maritime VHF Channel 70, which had been designated for Digital Selective Calling (DSC).

Following consideration of a DSC-based system, IMO received a further proposal from some Authorities from Scandinavia to consider a more robust transponder system. This would be automatic in operation, suitable for ship to shore and ship-to-ship purposes, use the maritime VHF band, and would cope with the density and operational intensity of shipping in congested areas.

The proposal was considered and IMO decided to adopt a single system based on the Scandinavian proposal. The system was called a Ship-borne Automatic Identification System (AIS).

The IMO Sub-Committee on Safety of Navigation (NAV) was requested to prepare a Performance Standard for such a system and this was completed during its forty-third session in 1997. It was titled Recommendation on Performance Standards for a Ship-borne AIS and was subsequently approved by the IMO Maritime Safety Committee (MSC) at its sixty-ninth session (May 1998) under resolution MSC.74 (69).

What is a Performance Standard? A Performance Standard specifies the operational requirement, as perceived by the user/operator. It states, for example, that the AIS equipment shall have the following, all provided by maritime VHF channels:

- Autonomous and continuous operation
- Ship-to-Ship capability
- Ship-to-Shore capability
- Information provision

Once NAV agreed on the Performance Standard, they requested the International Telecommunications Union (ITU) to prepare a Recommendation on the Technical Characteristics for the AIS.

1.5 INTERNATIONAL TELECOMMUNICATIONS UNION (ITU)

The ITU has its headquarters in Geneva and is a specialised agency of the United Nations within which governments and the private sector co-ordinate global telecommunication issues and services.

At the ITU World Radiocommunication Conference (WRC) in Geneva during October/November 1997, IMO requested that two maritime VHF channels be assigned for AIS. These were designated and a footnote was added to Appendix S18 of the ITU Radio Regulations titled "Table of Transmitting Frequencies in the VHF Maritime Mobile Band" as follows: -

"These channels (AIS 1 and AIS 2) will be used for an automatic ship identification and surveillance system capable of providing worldwide operation on high seas, unless other frequencies are designated on a regional basis for this purpose"

The channels allocated are: AIS 1 (161.975 MHz.) and AIS 2 (162.025 MHz.).

Under the initiative of IALA, a draft of the Technical Characteristics was prepared and submitted to a meeting of the ITU Radiocommunication Study Group, Working Party 8B in March 1998. A draft new Recommendation ITU–R M.1371-1 was prepared and titled, "Technical Characteristics for a Ship-borne Automatic Identification System (AIS) Using Time Division Multiple Access in The Maritime Mobile Band". This document was formally approved by ITU (November 1998) and is now the adopted technical standard for AIS.

This Recommendation specifies the following technical criteria, among others:

Transceiver characteristics
Modulation
Data format, messages and packaging
Time division multiple access (TDMA).
Channel management.

<u>NOTE:</u>
IALA has created and is maintaining a technical clarification document entitled Technical Clarifications of Recommendation ITU-R M.1371-1. This document is intended to clarify issues relating to ITU-R M.1371-1, pending a future revision.

1.6 INTERNATIONAL ELECTROTECHNICAL COMMISSION (IEC)

Founded in 1906, the International Electrotechnical Commission (IEC) is the world organisation that prepares and publishes international TEST standards for electrical, electronic and related equipment. The IEC has its headquarters in Geneva and prepares the type approval test specifications for ships mandatory equipment required under SOLAS.

Following the adoption of the IMO Performance Standard and the ITU Technical Characteristics for the AIS, there remained one more standard to prepare and adopt. This was the IEC Standard titled "IEC 61993 Part 2: Ship-borne Automatic Identification System (AIS). Operational and Performance Requirements, Methods of Testing and Required Test Results". This Standard is to be used by Administrations to "type approve" AIS equipment fitted on SOLAS Convention ships. The IEC Technical Committee 80 Working Group 8 (IEC/TC80/WG8) carried out the work, and the Standard was adopted in 2001. It includes, for example, the following:

Test specification
Data in/out standard
Connector standard
Built-in Test Unit details

1.7 IMO CARRIAGE REQUIREMENT

With the IMO Performance Standard, the ITU-R Technical Characteristics Standards, and the IEC Test Standard, IMO has included the AIS as a carriage requirement within the newly revised SOLAS Chapter V. AIS is included in the schedule of ship-borne navigational equipment proposed in Regulation 19 to be provided in a phased manner, starting with new buildings on or after 01 July 2002. All SOLAS vessels must have AIS by July 2008.

1.8 NON-SOLAS CONVENTION SHIPS

There are no international regulations that stipulate the navigation equipment to be fitted on non-SOLAS Convention ships, which comprise small fishing vessels, pleasure craft and inland waterway ships. It is expected however, that operators of these vessels and National Administrations will quickly realise the potential of AIS and its capability to enhance the safety of life at sea. For instance pleasure craft will not require all of the available data provided by AIS and will primarily be interested in ensuring that large ships identify them and recognise that they are a small craft. It is therefore expected that AIS will be produced and sold to the fishing and leisure industries but probably using less data; these should therefore be cheaper to provide. It is also expected that ships on inland and coastal waterways will use AIS equipment built to the International Standards mentioned earlier.

1.9 ADMINISTRATION / COMPETENT AUTHORITY SHORE INSTALLATIONS

The AIS concept began with ship-to-ship objectives and transitioned to the ITU and IEC standards for ship-borne mobile equipment. The need for AIS shore stations was recognised, and the updated guidelines for AIS shore stations and networks are included in part 2 of this document. ITU-R M.1371-1 compatibility is essential when specifying or selecting the equipment for installations.

1.10 AIS - KEY DATES

The development and acceptance of the AIS has in international timescales, been short, as can be seen from the following key dates.

1997 IMO Sub-Committee on Safety of Navigation approves a draft AIS Performance Standard.
1997 ITU World Radiocommunication Conference allocates two AIS VHF Channels.
1998 IMO Maritime Safety Committee adopts the AIS Performance Standard.
1998 IMO Maritime Safety Committee includes the AIS within Draft SOLAS Chapter V, Regulation 20.
1998 ITU adopts the AIS Technical Characteristics.
2001 IEC approves AIS Test Performance Standard 61993-2.
2001 IALA publishes the IALA Technical Clarifications of Recommendation ITU-R M. 1371-1
2002 IALA publishes IALA Guidelines on AIS, Version 1.0.
2002 IMO carriage requirement for AIS commences from July with a phased in approach.

1.11 RECOMMENDATIONS, STANDARDS AND GUIDELINES

The following International Recommendations, Standards and Guidelines apply to AIS equipment fitted on SOLAS Convention ships.

- **IMO** Recommendation on Performance Standards for a ship-borne Automatic Identification System (AIS), (MSC 74(69) Annexe 3)

- **ITU** Radio Regulations, Appendix S18, Table of Transmitting Frequencies in the VHF Maritime Mobile Band.

- **ITU** Recommendation on the Technical Characteristics for a Ship-borne Automatic Identification System (AIS) Using Time Division Multiple Access in the Maritime Mobile Band (ITU-R M.1371-1).

- **IEC** Standard 61993 Part 2: Class A Ship-borne equipment of the Universal Automatic Identification System (AIS) - Operational and Performance requirements, methods of testing and required test results.

- The following standards and specifications are being developed for approval during 2002:

  - IEC Standard 62287 Class B Ship-borne Automatic Identification System (AIS) operational and performance requirements, methods of testing and required test result.

  - IALA Guidelines on specification of shore station equipment and networking for inclusion in this version of the Guidelines.

PART 1 - OPERATIONAL ASPECTS OF AIS

2 OVERVIEW-OPERATIONAL & FUNCTIONAL REQUIREMENTS

2.1 GENERAL DESCRIPTION AND DEFINITION

Initially called the “Ship-Ship, Ship-Shore (4S)” broadcast transponder, this technology formed the basis of what eventually became known as the “Universal Ship-borne Automatic Identification System (AIS)”.

Very simply, AIS is an autonomous and continuous broadcast system, operating in the VHF maritime mobile band. It is capable of exchanging information such as identification, position, course, speed and more, with ships and shore. It can handle multiple reports at rapid update rates and uses Self-Organising Time Division Multiple Access (SOTDMA) technology to meet these high broadcast rates, ensuring reliable and robust operation.

AIS is now defined by an IMO Performance Standard (see 2.3.1), and has carried the name of “Universal AIS“ in order to set the standardised technology (specified in 2.3.3) apart from previous technologies, and precursor concepts known, now inappropriately, as AIS.

“Universal“ no longer appears as a descriptor or discriminator, which establishes the term “AIS“ as terminology for only the most current, certified and standardised system equipment.

2.2 PRINCIPLES OF AIS

The principle of AIS is to allow automatic exchange of shipboard information from the vessel’s sensors - inputted, static and voyage related data - between one vessel and another and between a vessel and a shore station(s).

Its principal functions are to facilitate:

- information exchange between vessels within VHF range of each other, increasing situational awareness.
- information exchange between a vessel and a shore station, such as a VTS, to improve traffic management in congested waterways.
- automatic reporting in areas of mandatory and voluntary reporting.
- exchange of safety related information between vessels, and between vessels and shore station(s).

2.3 COMPLIANCE

Ships covered by the SOLAS Convention are required to fit, as a mandatory requirement, various ‘navigation aids’ e.g. compass, radar etc. New equipment proposed for inclusion in the schedule of SOLAS requirements must comply with the following International Standards as applicable:

- a Performance Standard adopted by the International Maritime Organization (IMO)
- a Technical Specification adopted by the International Telecommunications Union (ITU)

- a Test (Type Approval) Standard adopted by the International Electrotechnical Commission (IEC).

2.3.1 IMO Performance Standard

The Performance Standard specifies the operational requirement as required by the user/operator and states that the AIS equipment shall have the following functions*:*

- Ship to ship capability
- Ship to shore capability, including long-range application
- Automatic and continuous operation
- Provide information messages
- Use maritime VHF channels.

IALA developed the initial draft of the standard for the IMO, gathering a special group of industry and national members for the task. This was refined at NAV 43 (July 1997) and formally adopted by MSC 69 on 11 May 1998, being issued as *Annex 3 to IMO Resolution MSC.74 (69) – Recommendation on Performance Standards for a Ship-borne Automatic Identification System (AIS).*

At the same time the IMO NAV 43 requested the ITU to prepare a Recommendation on the Technical Characteristics for the AIS and to allocate two worldwide channels for its use within the maritime mobile VHF band.

2.3.2 Details of Functional Requirements

In terms of system functionality, IMO Resolution MSC.74 (69), the Performance Standards for AIS, requires that the system should be capable of operating:

- in the ship-to-ship mode, to assist in collision avoidance;
- as a means for littoral States to obtain information about a ship and its cargo, and
- as a VTS tool, i.e. ship-to-shore (traffic management).

This functionality is further expanded in the Performance Standards to require the capability of:

- operating in a number of modes:
  - an "autonomous and continuous" mode for operation in all areas. This mode should be capable of being switched to/from one of the following alternate modes by a competent authority;
  - an "assigned" mode for operation in an area subject to a competent authority responsible for traffic monitoring such that the data transmission interval and/or time slots may be set remotely by that authority; and
  - a "polling" or controlled mode where the data transfer occurs in response to interrogation from a ship or competent authority.
- providing information automatically and continuously to a competent authority and other ships, without involvement of ship's personnel;
- receiving and processing information from other sources, including that from a competent authority and from other ships;
- responding to high priority and safety related calls with a minimum of delay; and
- providing positional and manoeuvring information at a data rate adequate to facilitate accurate tracking by a competent authority and other ships.

2.3.3 ITU Technical Standard

This specifies the technical characteristics of the system and lays down how to meet the operational requirements of the performance standard. It provides the technical criteria for the AIS, for example:

- Transceiver characteristics
- Modulation
- Data format, messages and packaging
- Time division multiple access (TDMA)
- Channel management.

At the initiative of IALA, a draft of the Technical Characteristics was prepared and submitted to a meeting of the ITU Radio Communication (ITU-R) Study Group, Working Party 8B in March 1998. A revision to the ITU Recommendation was prepared and formally approved by the Union in November 1998, being issued as:

ITU-R Recommendation M.1371-1 - Technical Characteristics for a Ship-borne Automatic Identification System Using Time Division Multiple Access in The Maritime Mobile Band.[1]

2.3.4 VHF Channel Allocation

The IMO request for two maritime VHF channels for AIS was submitted to the ITU World Radio Communication Conference (WRC) in Geneva during October/November 1997. Two channels were designated and a footnote added to Appendix S18 of the ITU Radio Regulations titled "Table of Transmitting Frequencies in the VHF Maritime Mobile Band" as follows: -

These channels (AIS 1 and AIS 2) will be used for an automatic ship identification and surveillance system capable of providing worldwide operation on high seas, unless other frequencies are designated on a regional basis for this purpose"

The channels allocated are AIS 1 (161.975 MHz.) and AIS 2 (162.025 MHz.)

2.3.5 IEC Test Standard

IEC prepares the Type Approval Test Specifications for ships mandatory equipment required under SOLAS, which in the case of AIS includes:

- Test specification
- Data in/out standard
- Connector standard
- Built-in Integrity Test (BIIT) details.

The IEC Test Standard for AIS is 61993-2 - Ship-borne Automatic Identification System (AIS) Operational and Performance Requirements, Methods of Testing and Required Test Results".[2]

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[1] The ITU-R had earlier issued another AIS related recommendation (without any formal request from IMO) entitled *"ITU-R M.825-2 - Characteristics of a transponder system using DSC techniques for use with VTS and Ship-to-ship identification."*

[2] This standard supersedes IEC Standard 61993-1 on DSC AIS transponders.

2.4 SOLAS CARRIAGE REQUIREMENTS

The international requirement for the carriage AIS as ship-borne navigational equipment on vessels is detailed within Chapter V (Safety of Navigation) Regulation 19, of the revised SOLAS Convention.

In mandating the new carriage requirement a phased approach was taken to its implementation. SOLAS Regulation V/19 requires that *"All ships of 300 gross tonnage and upwards engaged on international voyages and cargo ships of 500 gross tonnage and upwards not engaged on international voyages and passenger ships irrespective of size shall be fitted with Automatic Identification System (AIS), as follows:*

- ships constructed on or after 1 July 2002;
- ships engaged on international voyages constructed before 1 July 2002;
    - in the case of passenger ships not later than 1 July 2003;
      in the case of tankers, not later than the first [survey for safety equipment] after 1 July 2003;
    - in the case of ships, other than passenger ships and tankers, of 50,000 gross tonnage and upward, not later than 1 July 2004;
    - *in the case of ships, other than passenger ships and tankers, of 300 gross tonnage and upwards but less than 50,000 gross tonnage, not later than the first [survey for safety equipment] after 1 July 2004 or by 31 December 2004, whichever occurs earlier;** and
- ships not engaged on international voyages constructed before 1 July 2002, not later than 1 July 2008."

** As determined at IMO Conference of Contracting Governments to the International Convention for the Safety of Life at Sea, 1974: 9-13 December 2002.*

There is nothing in the SOLAS regulations, which prevents Administrations from requiring their nationally registered (domestic) vessels within their jurisdiction to implement the new SOLAS regulation in advance of the promulgated date.

2.5 CARRIAGE REQUIREMENT FOR OTHER VESSELS

Administrations also have scope under SOLAS V/1.4 to determine to what extent the provisions of the regulation will apply for

.1 ships below 150 gross tonnage on all voyages;
.2 ships below 500 gross tonnage not engaged on international voyages; and
.3 fishing vessels.

Administrations are expected to consider domestic AIS requirements to include a range of smaller vessel categories including recreational craft, appreciating the proportionality of AIS effectiveness to inclusiveness of such carriage requirements.

2.6 CLASS A AND CLASS B SHIP-BORNE MOBILE EQUIPMENT

In recognition of this requirement, allowance has been made in the AIS Technical Standards (ITU-R M.1371-1) for both Class A and Class B Ship-borne Mobile Equipment. Class A equipment complies with the IMO AIS carriage requirement while the Class B provides capabilities not necessarily fully compliant with IMO requirements, but necessarily system-compatible, to perform satisfactorily on the VDL.

Class B equipment, for example, transmits reports at less frequent intervals than the Class A standards (see Tables 3 & 2 respectively).

Administrations have the responsibility of determining the applicability of Class A or Class B equipment to vessel categories, via processes conducted under paragraph 2.5 above.

2.7 INLAND WATERWAYS

As an example of a regional inland approach to AIS use, modified AIS carriage is contemplated for certain European waterways where the mix of ocean/sea and inland vessels cause great complication and congestion. Multi-national river commissions will regulate policy and practice, setting precedent for other Administrations and regions to follow in similar inland scenarios where radio frequency availabilities permit.

For such inland applications, development of 'Class A derivative' AIS equipment has been considered, providing full SOTDMA functionality, but not involving DSC components, to achieve radio frequency agility. As the AIS position sensor may also be the inland vessel's only position fixing device, new regionalized procedures may be necessary for display interface. The messaging process may also need regionalized adjustment.

2.8 AIDS TO NAVIGATION

In addition to its primary role, an AIS station can be used as an aid to navigation. It can provide information and data that would serve to:

- complement or replace an existing aid to navigation;
- provide identity, state of "health" and other information such as real time tidal height, tidal stream and local weather to surrounding ships or back to the shore authority;
- provide the position of floating aids (primarily buoys) by transmitting an accurate position (based on DGPS corrections) to monitor that they are "on station";
- provide information for performance monitoring, with the connecting data link serving to remotely control changes of AtoN parameters or switching in back-up equipment;
- provide longer range detection and identification in all weather conditions; and
- provide complete information on all AIS fitted shipping traffic passing within VHF range of the site.

There are three ways of implementing AIS on aids to navigation:

i) Install an actual AIS mobile unit on a real aid to navigation and use the AIS mobile message format to broadcast information related to the AtoN, or such other data as the competent authority may deem appropriate.

ii) Create synthetic AIS AtoN (i.e. where data from the aid is transferred to another location from where the AIS messages relating to the aid are sent):

a. “validated” data – the aid exists and its position can be validated from the aid, but the transmission is coming from another location (either from the shore or from another aid)

b. “unvalidated” data – the aid exists, but its position cannot be validated. In this case, it may be off-station and, hence, the AIS would be transmitting ‘bad’ AIS information. The AIS transmission is coming from shore or another aid. An ‘unvalidated’ Synthetic AIS may lead to potential navigation problems if used with a floating AtoN.

iii) Create a virtual AIS where the AIS message is an aid to navigation message, but no aid exists at the location. A virtual AIS may be useful for short-term temporary marks, but they should not be seen as a permanent AtoN solution at this stage.

3 OPERATION OF AIS

3.1 ONBOARD OPERATIONAL USE OF SHIPBORNE AIS

The AIS is a ship-to-ship, ship to shore broadcast system. In the ship-to-ship mode of operations, IMO has provided “Guidelines for the Onboard Operational Use of Automatic Identification Systems (AIS)” for the mariner.

CAUTION

NOT ALL SHIPS CARRY AIS

The Officer of the Watch (OOW) should always be aware that other ships and, in particular, pleasure craft, fishing boats and warships, and some shore stations including Vessel Traffic Service (VTS) centres, might not be fitted with AIS.

The OOW should always be aware that AIS fitted on other ships as a mandatory carriage requirement, might, under certain circumstances, be switched off, based on the Master’s professional judgement.

3.2 BASIC OPERATION PROCEDURES

The ship-borne AIS unit is connected to a power source, an antenna and to a variety of on board equipment, including the integrated navigation system where available. In addition, at the time of installation, important static-ship-related information has to be entered into the AIS memory unit; this includes identity, length and beam, type of ship and the location of the position-fixing antenna.

The unit will be fitted with, at least, a minimum keyboard and display (MKD) or a dedicated dynamic display which interfaces with the AIS and performs two functions:

- displays the unit’s operational status (which should be regularly checked); and
- displays target information, which is used as described in the Guidelines.

3.3 OPERATION DURING THE VOYAGE

The AIS, once activated, will continuously and autonomously broadcast the vessel's position and all the static and dynamic information as required by the IMO performance standards.

However, while the vessel's speed and rate of turn manoeuvres will automatically determine the update rate, there remains a need for the Master or an authorised person to manually input, at the start of the voyage and whenever changes occur, the following "voyage related data":

- ship's draught;
- type of hazardous cargo (most significant hazard carried);
- destination and ETA (at master's discretion);
- route plan (way-points – at master's discretion);
- the correct and actual navigational status; and
- short safety related short messages, when appropriate.

Optional Voyage related data:

- Air draught (maximum height of vessel above water level)

NOTE: For specific message type see chapter 8.

The potential of AIS as an anti-collision device is recognised and AIS may be recommended as such a device in due time. When used in conjunction with the application of the Collision Regulations and good watch-keeping practice, it will enhance situational awareness.

The minimum mandated display provides for not less than three lines of data consisting of bearing, range and name of a selected ship. Other data of the ship can be displayed by horizontal scrolling of data, but scrolling of bearing and range is not possible. Vertical scrolling will show all other ships known to AIS.

For more detailed information on the use of AIS in collision avoidance, please refer to "Use of AIS information in Collision Avoidance", Chapter 9.1.

3.3.1 ACTIVATION

AIS should always be in operation. It is recommended that the AIS is not switched off during port stays because of the value of the ship information to port authorities.

Whether at sea or in port, if the Master believes that the continued operation of AIS might compromise the ship's safety or security, the AIS may be switched off; however, the equipment should be reactivated as soon as the source of danger has disappeared. This might be the case in sea areas where pirates and armed robbers are known to operate. It may be necessary to switch off AIS or to reduce the transmission power during some cargo handling operations. Actions of this nature should always be recorded in the ship's logbook.

If the AIS is shut down, static data and voyage related information remains stored. Restart is achieved by simply switching on the power to the AIS unit. Own ship's data will be transmitted after a two-minute initialisation period.

3.3.2 INTEGRITY CHECK

AIS provides:

- a built-in integrity test (BIIT) running continuously or at appropriate intervals;
- monitoring of the availability of the data;
- an error detection mechanism of the transmitted data; and
- error checking of the received data.

If no sensor is installed or if the sensor (*e.g.* the gyro) fails to provide data, the AIS automatically transmits the "not available" data value. However, the integrity check cannot validate the accuracy of the data received by the AIS.

3.4 OPERATION ON BOARD IN A COASTAL AREA, SHIP REPORTING SYSTEM (SRS) AREA OR EXCLUSIVE ECONOMIC ZONE (EEZ)

Additionally, AIS allows shore authorities to monitor vessels operating within their coastal waters, designated mandatory SRS area or EEZ, as appropriate. All vessels fitted with AIS should be able to automatically provide the majority of any reports required when within VHF range.

The information that will be available to a polling Authority will be available via a long range message provided through the AIS Long Range serial interface and not via the standard VHF Data Link (VDL) messages (see Long range message, Chapter 7).

AIS is also provided with a two-way interface for connecting to long-range communication equipment. Initially, it is not envisaged that AIS would be able to be directly connected to such equipment. A shore station would first need to request that the ship makes a long range AIS information transmission. Any ship-to-shore communication would always be made point-to-point, and not broadcast. Once communication has been established (e.g. via INMARSAT C), the ship would have the option of setting its AIS to respond automatically to any subsequent request for a ship report, from that shore station, or at regular intervals as appropriate.

It should be noted that the medium for transmission is still to be decided at the time of writing.

This will ensure a quicker response to emergencies such as search and rescue (SAR) as well as environmental pollution response and will enable the coastal state to assess the navigational requirements or improvements that may be necessary to navigational safety in such areas. Many benefits can be realised from such monitoring, such as better traffic routeing, port and harbour planning and more safety related information exchange.

4 OPERATION OF AIS ASHORE

4.1 USE OF AIS IN VTS

This section of the IALA Guidelines on AIS consolidates the original content of *IALA Recommendation on AIS as a VTS Tool*. It also seeks to identify, for the benefit of VTS authorities, the ways in which AIS contributes to the achievement of the following tasks.

4.1.1 IMO GUIDELINES FOR VTS

IMO Assembly Resolution A.857 (20), Guidelines for Vessel Traffic Services, establishes the following tasks that should be performed by a VTS:

> *A VTS should at all times be capable of generating a comprehensive overview of the traffic in its service area combined with all traffic influencing factors. The VTS should be able to compile the traffic image, which is the basis for the VTS capability to respond to traffic situations developing in the VTS area. The traffic image allows the VTS operator to evaluate situations and make decisions accordingly. Data should be collected to compile the traffic image. This includes:*
>
> - *Data on the fairway situation, such as meteorological and hydrological conditions and the operational status of aids to navigation;*
> - *Data on the traffic situation, such as vessel positions, movements, identities and intentions with respect to manoeuvres, destination and routing;*
> - *Data on vessels in accordance with the requirements of ship reporting and, if necessary, any additional data required for effective VTS operations.*

4.1.2 INSTALLATION OF AIS INTO A VTS

4.1.2.1 Number/location of base stations/repeaters

In deciding the size, and thus cost, of integrating AIS into a VTS system, a careful study needs to be undertaken to establish practically the number and location of base and repeater stations required to achieve full and reliable coverage of the region and the expected traffic load. Although VHF reception is greatly influenced by antenna location and height, operation in a ‘noisy’ electronic environment may necessitate the installation of additional base stations in order to reduce vulnerability to interference.

4.1.2.2 Interoperability with adjacent VTS

Where it proves necessary to use more than one centre, or where a VTS authority involves more than one VTS centre, the method of connecting the component elements into a local network needs to be given careful consideration. In particular, the existence of, or plans for, a regional network may necessitate using a local networking solution, which is compatible with national and international networks.

4.1.2.3 Availability of VHF communication channels

Two maritime VHF channels have been allocated by the ITU for the international use of AIS in its primary ship-to-ship mode. What is not yet certain is whether additional local channels will need to be allocated to support the operation of VTS within certain congested VTS environments. The need for such additional channels will be at its most acute where large numbers of vessels navigate within a VTS area, and where the VTS centre has a particular interest in deriving vessel identity at maximum range. As has been described previously, AIS in an overload situation will discount AIS signals received from the extremity of an area, before those emanating from vessels or craft close to the receiving station.

4.1.2.4 Availability of national/regional/local DGNSS corrections

In order to monitor vessel navigation with the 10-metre accuracy potentially possible, a reliable DGNSS correction signal will need to be made available to all vessels throughout the VTS area. Such services are provided nationally or regionally in some areas. Where such a service does not exist, a VTS authority may consider providing these corrections itself. It is technically possible to transmit the relevant corrections using the AIS itself.

4.1.3 OTHER ISSUES TO BE TAKEN INTO CONSIDERATION

4.1.3.1 Integration of AIS into existing radar based systems

Radar based VTS systems often differ in the way radar video is handled and processed, prior to presentation of the traffic image. System design and age are thus likely to influence the options for successfully integrating AIS. A full appreciation of those options, together with any consequences, will normally only be possible after consultation with the relevant manufacturers.

In many VTS areas, vessel traffic is varied and includes both SOLAS and non-SOLAS vessels. In these circumstances, radar will remain the primary sensor for detecting vessels not fitted with AIS. Economies in infrastructure are therefore unlikely.

AIS data is transmitted at variable rates depending upon vessel speed and manoeuvre. In contrast, radar data is generated at a constant rate as defined by the antenna rotation speed. The integration of AIS into a radar based VTS system thus needs to be capable of achieving and maintaining the correlation of AIS and radar data originating from the same vessel, despite unpredictable variations in data rates. The potential benefits of AIS would be quickly reduced, should the process of integration result in the generation of numerous false tracks.

4.1.3.2 Use of electronic charts

VTS systems have traditionally used a schematic representation of the geographical and hydrographic features of the relevant area as the background to the traffic image. The accuracy of such representations, however, is not suitable for precise navigation. With the advent of electronic charts, there are clear benefits to be gained from using such charts as the background to the traffic image. By so doing, vessel navigation may be monitored and/or assisted, in relation to precisely charted features. In VTS systems not fitted with electronic charts, such information or assistance can only be given in relation to radar detectable features, such as coastline or navigational buoys, or as depicted on existing VTS display diagrams.

Where reliance is to be placed on electronic charts for this purpose, it is important that an approved hydrographic office issues them, thus ensuring data is accurate, and up to date. It is anticipated that VTS authorities will be able to broadcast local chart corrections to suitably equipped (ECDIS/ECS) vessels and to issue navigational warnings electronically using AIS.

In confined waters, it is likely that VTS operators in monitoring vessel manoeuvres will occasionally have need to reduce the scale of their displays. In such circumstances, it will be important that the electronic chart acting as the background to the traffic image, is capable of showing increasing levels of survey detail, as operators reduce the scale on their displays. This will only be possible where the electronic chart is compiled from source survey data, rather than from an existing paper chart. In these circumstances, it will also be important that the charted location of radar sites is accurate to a maximum of 10 metres, if errors between radar and AIS generated tracks, which will be all the more obvious at reduced range scales, are to be avoided.

IHO standard S52 defines the standards for symbols and colours on official electronic charts. Four variations of the basic colour scheme are available. These colour schemes, whilst optimised for navigation in varying light conditions on the bridge of a vessel, may not be suitable for VTS purposes ashore, particularly where operators are required to study a display constantly for long periods.

4.1.3.3 Choice of VTS Symbols

These symbols may be found to be unsuitable for VTS purposes, for two reasons. Firstly, those selected to represent AIS tracks may need to be accommodated logically within an existing framework of symbols. Secondly, VTS centres will often have need to represent visually on the traffic image, a much wider range of information than is necessary onboard a vessel. For example, traffic management may necessitate the use of symbols that depict different types and sizes of vessels. Alternatively, it may be necessary to show which vessels have pilots embarked, and which do not.

Where it is required for a VTS to transmit an synthetic or virtual AIS target to an AIS/ECDIS fitted vessel, it will be necessary for that information to be transmitted in terms which will be recognised by the vessel, however it is represented internally within a VTS centre.

4.1.4 BENEFITS OF AIS

4.1.4.1 Automatic Vessel Identification

Constant operation of AIS brings many benefits to the mariner. Principal amongst these, as the name implies, is the automatic and immediate provision of vessel identity (MMSI, call sign etc), thereby facilitating rapid radio communication where necessary. This benefit is of equal, if not even greater, value to VTS authorities.

Most VTS organisations require vessels to report to the VTS centre when approaching or entering the VTS area. Achieving vessel identity relies on such vessels reporting both identity and location to the VTS centre, and the VTS operator then correlating this information with, say, an unassigned radar target.

The identification process is time consuming and wholly reliant on the co-operation of participating vessels. It is not uncommon for vessels to inadvertently fail to comply with this requirement, thereby creating a potentially dangerous situation, and creating further distraction for the VTS operator. Even where VHF direction finding equipment is fitted, the VTS traffic image is still reliant on vessels reporting identity via VHF thereby permitting the correlation of identity with the track identified by DF. AIS will help overcome the shortcomings and time-consuming procedures inherent in the present arrangements.

4.1.4.2 Improved Vessel Tracking

- **Wider geographical coverage**
  AIS data will be received by other AIS units, or by base or repeater stations. Thus where a VTS organisation is fitted with such equipment, it will be capable of receiving both the identity and precise location of a vessel at the maximum reception range of the VHF radio communications frequency. As a consequence, it will often permit detection of targets well outside the conventional radar range. Even where this is not possible, due to the need to screen base stations from adjacent VHF interference, extended VTS detection range may be achieved by the installation of additional base or repeater stations connected into a network at much lower cost than radar.

- **Greater positional accuracy**
  AIS aims to achieve positional accuracies of 'better than 10 metres' when associated with DGNSS correction signals. This compares favourably with radar, which as a function of frequency, pulse repetition rate, and beam width, will often only achieve positional accuracy in the range 30 to 50 metres.

- **Absence of "radar shadow" area**
  In coastal and harbour waters radar tracking of vessels can be masked, or otherwise affected by the proximity of land and buildings. The resultant "shadow" areas can cause a radar based VTS to lose track, thereby denying the VTS centre the ability to monitor accurately vessel movement at what could be a critical time. The loss of tracking will invariably result in the need to reacquire and re-identify lost tracks, thereby increasing the workload within the VTS centre.

  Whilst AIS tracks will avoid the great majority of such effects, the very close proximity of buildings and bridges, sometimes known as the "urban canyon" effect, can cause difficulties for AIS transponders in heavily built-up areas. This is a consequence of inhibiting either the reception of the differential GNSS signal by the AIS transponder, or the transmission of the subsequent AIS message.

- **Traffic image accuracy**
  Radar tracking can similarly be interrupted when two vessels pass close to one another, with the result that the radar tracking of one contact is confused by the proximity of the other. Importantly, this can result in the identity of one track transferring or "swapping" to the other. Such a situation introduces a potentially dangerous inaccuracy in the vessel traffic display image, unless noticed and rectified quickly by VTS operators. Again, the consequence of this phenomenon is further work for the VTS centre. The more precise tracking associated with AIS has been shown to prevent the incidence of "track swap".

- **Real Time Manoeuvring Data**

  Radar based VTS systems will typically provide details of a vessel's course and speed over the ground. Of necessity, this information is historical in that it is calculated from the track made good by a vessel. In contrast, AIS will provide all recipients with certain elements of real time manoeuvring data such as Ships Heading and Rate of Turn. These are derived directly from the vessel navigation systems and are included automatically in the Dynamic Message broadcast by the AIS.

- **Weather Effects On Tracking Performance**

  Navigational radar performance is often adversely affected by precipitation as a function of the radio frequency on which it operates. In heavy rain or snow, effective radar tracking is sometimes unachievable, even with the use of modern suppression techniques. VHF radio transmissions on the other hand are not so attenuated. As a consequence, a VTS centre is much more likely to maintain an accurate traffic image in adverse weather where that tracking is based on AIS data.

  VHF radio transmissions can be affected by atmospheric ducting. In these conditions, VHF reception ranges can be greatly extended. Where such an enhanced reception range brings with it the detection of greatly increased AIS messages, the system will automatically overcome the risk of overloading by ignoring signals originating from vessels at greatest range, and re-using the slots so gained.

- **Provision of more precise navigational information / advice**

  It follows that where a VTS centre is able to receive AIS information from vessels within or adjacent to its area, the quality, accuracy and reliability of vessel tracking will be improved markedly. As a consequence, that VTS centre which offers a Navigational Assistance Service or a Traffic Organisation Service will be able to offer more precise advice. Moreover, the availability of certain real time manoeuvring data within the VTS centre will enable VTS operators to appreciate more rapidly, and in greater detail, actual vessel movement. It should be stressed, however, that this facility alone will not enable a VTS centre to provide detailed manoeuvring advice or direction to a vessel.

4.1.4.3 Electronic transfer of sailing plan information

Where AIS is integrated into a VTS system and the appropriate software is available, it becomes possible for vessels and the VTS centre to exchange passage information such as intended way points.

4.1.4.4 Electronic transfer of safety messages

The facility available within AIS for the transmission of short safety messages makes possible the electronic broadcasting from a VTS centre of local navigation warnings, and similar safety related messages.

It should also be noted that this information is more accurately (faster update rate) available to a vessel fitted with AIS and should be appropriately used.

4.1.4.5 Automatic indication of Voyage Related Information (cargoes, dangerous goods, etc)

Vessels are normally required to report to the VTS authority that dangerous goods are being carried. The AIS voyage related message permits the inclusion and automatic transmission of this information.

4.1.5 SHORE TO VESSEL AIS SERVICES

There exist international AIS messages designed to facilitate the reception onboard of online and static information from shore such as hydrographical, hydrological, meteorological, aids to navigation, and warning messages. Local specific messages can also be made available to fit local demands.

4.1.5.1 USE OF AIS AS AN AID TO NAVIGATION (AtoN)

The remote control and monitoring of aids to navigation has been developed primarily to enable service providers to ensure that aids and supporting systems are functioning correctly and where required, to organise maintenance.

Until now, there has been no simple, cost-effective and universal method of communicating such information. The introduction of AIS presents an opportunity to provide such information to service providers and mariners, using internationally standardised and recognised equipment, message protocols and frequencies.

The operation and performance of aids to navigation can be monitored or controlled using an AIS data link as the interface with the service provider. It is possible to have an aid transmit its identity, operational status and other information such as real time wave height, tidal stream and local weather to ships nearby or to the service provider. Buoys that can transmit an accurate position, perhaps based on DGNSS, can be monitored to ensure that they are on station. Performance monitoring, remotely changing operating parameters, and activating back-up equipment are also made possible by the use of AIS.

4.1.5.2 USE OF AIS FOR METEOROLOGICAL AND HYDROLOGICAL PURPOSES

Another application, whose wide use is expected, is the transmission of meteorological and/or hydrological data. Where such an application is intended for international use, the message format will be registered by IALA prior to being made available to system manufacturers. This will facilitate the correct presentation of the information on systems from different manufacturers.

Options for implementing this application include:

- Connecting a sensor directly to a local AIS-unit, which then broadcasts the relevant information.
- Several sensors can be connected to a shore station network via a data communication system. Information can then be broadcast as required.
- A sensor can be co-located with an AtoN equipped with AIS. The AIS-unit can then be used to broadcast both the AtoN information and meteorological and/or hydrological information using separate messages.

The information to be broadcast will depend on the operational requirement and the availability of measuring and processing equipment. Examples include:

- Wind speed, average and gust values
- Wind direction
- Water level
- Water temperature
- Air temperature
- Current speed and direction on different depths
- Tide information

Such data permits the presentation of real time information at receiving stations, including onboard ships within VHF range.

4.1.5.3 SILENT VTS

The AIS allows the silent and automatic exchange of information with other vessels and VTS centres, leaving port operation VHF channels available for safety purposes and emergency situations. Thus AIS reduces the workload on the bridge of the vessel and also in the VTS centre. In ports where the density of the traffic is low, the AIS fitted vessels may form their own “Silent VTS” without any shore station. In busy ports AIS will reduce the VTS operators’ workload and allow them to increase their efficiency in traffic management, information services and other tasks.

4.1.5.4 Archiving data

The automatic availability within a VTS centre of AIS data for each vessel facilitates the rapid and comprehensive recording, replay and archiving of data.

4.1.5.5 System redundancy

By equipping VTS centres with AIS, an alternative method of tracking and monitoring vessel navigation is introduced, thereby improving system redundancy significantly.

4.1.5.6 Potential for interaction within regional AIS network

Increasing emphasis is being placed on networking VTS centres on a regional basis. Such an arrangement facilitates greater efficiency by making possible the rapid transfer of vessel details between different centres. Adoption of AIS within the relevant VTS centres may contribute toward this process.

4.1.5.7 Improved SAR Management

Many marine and VTS authorities are equipping or intend to equip SAR capable units, including aircraft and helicopters, with AIS. The AIS voyage related message permits a vessel to transmit the number of persons onboard. Whilst this is not mandatory for vessels at sea, it can be made a formal requirement in a VTS area. The provision of such details, and the ready identification and location of SAR units greatly facilitates the management and evaluation of any SAR response.

4.1.6 PERSONNEL AND TRAINING

For information on personnel and training, refer to IALA Model Courses V103-1, V103-2, V103-3 and its associated task book and V103-4.

4.1.7 SHORT TERM ACTION BY VTS AUTHORITIES

AIS equipment is to be implemented as a mandatory carriage requirement under SOLAS Chapter V for newly constructed vessels from 1 July 2002 and progressively thereafter for other vessels by 1 July 2008.

VTS authorities therefore need to consider, as a matter of priority, whether they intend integrating AIS into their VTS system. As the previous paragraphs will have demonstrated, the inclusion of AIS into a VTS system significantly enhances the precision and reliability with which AIS equipped vessels may be monitored, and thus enhances safety.

AIS also has the potential to improve efficiency in vessel traffic and port management. The degree, to which this potential may be realised, will vary depending on the operational circumstances. It is for each VTS authority to make that assessment.

4.2 OPERATION OF AN AIS IN A SRS AREA OR TSS

AIS also assists vessels operating in a Ship Reporting System (SRS) area or Traffic Separation Scheme (TSS) at the same time ensuring that the responsible shore authorities have the ability to easily identify vessels, to automatically receive from them a wealth of useful information and to communicate with them using the AIS functionality.

Information received and transmitted through AIS enables shore authorities to better monitor and organise (where such service is provided) the traffic in the particular area of the Ship Reporting System (SRS) and to provide related information, assistance or transmit instruction to the vessel related to its voyage in the SRS area.

VTS' should electronically acknowledge vessel entry into AIS-equipped areas, to preclude voice queries about receipt of vessel's AIS data.

VTS or shore authorities have the ability to send either addressed or broadcast binary messages. This function enables traffic related information to be exchanged with vessels in a designated geographic area. Please refer to "AIS Messages" Chapter 8 for further information.

The long range reporting and polling functions allow areas to be monitored and vessel reports to be transmitted outside the normal AIS (VHF range) operational areas.

CAUTIONARY NOTE

In order to avoid a situation whereby AIS fitted vessels incorrectly believe that a VTS authority is receiving data being transmitted via the AIS, all VTS authorities should publish by appropriate means their status in respect of AIS. Where applicable, the date on which they intend to incorporate AIS should also be promulgated well in advance.

5 FUNCTIONAL REQUIREMENTS OF AIS

5.1 INTEGRATION AND DISPLAY OF AIS INFORMATION

5.1.1 Display issues

Some of the following items (which appear as the headings of unfilled sub sections in this part) have been identified as those to be addressed in the future. Each is being discussed in many forums and there are no outcomes at the time of revising this document.

- **Display on Radar**
  This matter is being addressed by IEC TC80 WG 13 and this work is expected to be completed in 2004.
- **Display on ECDIS**
  This matter is being addressed by IEC TC80 WG 13 and this work is expected to be completed in 2004.
- **Display on Dedicated Graphics Display**
  This matter is being addressed by IEC TC80 WG 13 and this work is expected to be completed in 2004.
- **Display on Integrated Navigation Systems**
  This matter is being addressed by IEC TC80 WG 13 and this work is expected to be completed in 2004.
- **Display of Navigation Warnings**
  This matter is being addressed by IEC TC 80 WG 13 and this work is expected to be completed
- **Display of Meteorological Warnings**
  This matter is being addressed by IEC TC 80 WG 13 and this work is expected to be completed
- **Display of Shipping Information**
  This matter is being addressed by IEC TC 80 WG 13 and this work is expected to be completed

5.1.1.1 On board display requirements

In developing the Test Standard IEC 61993-2, the IEC Technical Committee 80 specified a “minimum display requirement for AIS” in order to validate the proposed test functions. This requires, as a minimum, a display of at least three lines of 16 alphanumeric characters, which is sufficient to obtain the target vessel’s identity and position. This positional information is displayed relative to the observing vessel.

However, to obtain the full benefit of the AIS capability, the system should be integrated to one of the existing graphical displays on the bridge, or a dedicated graphical display. Greater functionality will be provided by a more capable graphical display, but selection of the type of display is dependent on the user requirement and options offered by manufacturers.

The IMO Performance Standard leaves the question of display requirements unspecified although the assumption has been that, ideally, the AIS information would be displayed on the ship’s radar, electronic chart display and information system (ECDIS) or another dedicated electronic display such as that provided or an Integrated Navigation System (INS). This would provide the greatest benefit to the mariner. The AIS has the facility to show this information on an external display medium or integrated into ECDIS/ECS and/or a radar display.

At its 47th session (2 to 6 July 2001), the IMO Sub-Committee on Safety of Navigation (NAV), agreed on interim guidelines for the presentation and display of AIS target information. The interim guidelines deal with the graphical presentation and display of AIS target data in standalone or integrated navigational aids systems and are considered as interim performance guidelines. It is intended to replace them with appropriate performance standards after experience has been gained. These interim guidelines have been established to allow manufacturers to develop the relevant equipment and functions in time and to allow mariners to acquaint themselves with the use of intelligent combination of information from the first date of AIS deployment.

5.1.2 Definitions and symbology

- **Sleeping target**
  A target symbol indicating the presence and orientation of a vessel equipped with AIS in a certain location. No additional information is presented until activated thus avoiding information overload.
- **Activated target**
  A symbol representing the automatic or manual activation of a sleeping target for the display of additional graphically presented information including:
  a vector (speed and course over ground);
  the heading; and
  ROT or direction of turn indication (if available) to display actually initiated course changes.
- **Selected target**
  A symbol representing the manual selection of any AIS target for the display of detailed information in a separate data display area. In this area, received target data as well as the calculated CPA and TCPA values will be shown.
- **Dangerous target**
  A symbol representing an AIS target (activated or not) which data contravene pre-set CPA and/or TCPA limits.
- **Lost target**
  A symbol representing the last valid position of an AIS target before the reception of its data was lost.

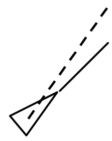
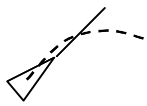
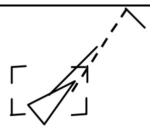
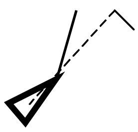
AIS target	Symbol	Description of symbol
AIS target (sleeping)		An isosceles, acute-angled triangle should be used with its centroid representing the target's reference position. The most acute apex of the triangle should be aligned with the heading of the target, or with its COG, if heading information is not available. The symbol of the sleeping target may be smaller than that of the activated target.
Activated AIS target	 	An isosceles, acute-angled triangle should be used with its centroid representing the target's reference position. The most acute apex of the triangle should be aligned with the heading of the target, or with its COG, if heading information is not available. The COG/SOG vector should be displayed as dashed line starting at the centroid of the triangle The heading should be displayed as solid line of fixed length starting at the apex of the triangle A flag on the heading indicates a turn and its direction in order to detect a target manoeuvre without delay A path predictor may also be provided
Selected target		A square indicated by its corners should be drawn around the target symbol.
Dangerous target		A bold line clearly distinguishable from the standard lines should be used to draw the symbol. The size of the symbol may be increased. The target should be displayed with: vector, heading and rate of turn indication. The symbol should flash until acknowledged. The triangle should be red on colour displays.
Lost target		A prominent solid line across the symbol, perpendicular to the last orientation of the symbol should be used. The symbol should flash until acknowledged. The target should be displayed without vector, heading and rate of turn indication.

Table 1: Recommended AIS Target Symbols

- If colour fill is used no other information should be masked or obscured.
- Base stations may transmit information on targets tracked by other means. If these targets are displayed they should be presented using symbols clearly distinguishable from the symbols above.
- Further symbology for special situations will be developed.

5.1.3 OPERATIONAL REQUIREMENTS

In addition to the relevant performance standards, AIS information may be presented and displayed according to the following interim guidelines.

5.1.4 PRESENTATION OF INFORMATION

If AIS information is made available for a graphical display, at least the following information should be displayed: (see resolution MSC 74(69), Annex 3 (AIS), paragraph 6):

1. position;
2. course over ground;
3. speed over ground;
4. heading; and
5. rate of turn, or direction of turn, as available.

If information provided by AIS is graphically presented, the symbols described in the Appendix should be applied. In the case of a radar display, radar signals should not be masked, obscured or degraded.

Whenever the graphical display of AIS targets is enabled, the graphical properties of other target vectors should be equivalent to those of the AIS target symbols, otherwise the type of vector presentation, (radar plotting symbols or AIS symbols), may be selectable by the operator. The active display mode should be indicated.

The presentation of AIS target symbols, except for sleeping or lost targets, should have priority over other target presentations within the display area, including targets from EPA, ATA or ARPA. If such a target is marked for data display, the existence of the other source of target data may be indicated, and the related data may be available for display upon operator command.

The mariner should be able to select additional parts of the information from AIS targets, which should then be presented in the data area of the display, including the ship's identification, at least the MMSI. If the received AIS information is not complete, this should be indicated.

A common reference should be used for the superimposition of AIS symbols with other information on the same display, and for the calculation of target properties (e.g. TCPA, CPA.).

If AIS information is graphically displayed on radar, the equipment should be capable of appropriately stabilizing the radar image and the AIS information.

Target data derived from radar and AIS should be clearly distinguishable as such.

The operator may choose to display all or any AIS targets for graphical presentation. The mode of presentation should be indicated.

If the display of AIS symbols is enabled, removing a dangerous target should only be possible temporarily as long as the operator activates the corresponding control.

The AIS symbol of an activated target may be replaced by a scaled ship symbol on a large scale/small range display.

If the COG/SOG vector is shown, its reference point should be either the actual or the virtual position of the antenna.

Means should be provided to select a target or own ship for the display of its AIS data on request. If more than one target is selected, the relevant symbols and the corresponding data should be clearly identified. The source of the data, e.g., AIS, radar, should be clearly indicated.

5.1.5 PROCESSING OF INFORMATION

If zones or limits for automatic target acquisition are set, these should be the same for automatically activating and presenting any targets regardless of their source.

The vector time set should be adjustable and valid for presentation of any target regardless of its source.

If radar-plotting aids are used for the display of AIS information, these should be capable of calculating and displaying collision parameters equivalent to the available radar plotting functions.

If the calculated CPA and TCPA values of an AIS target are less than the set limits,

- a dangerous target symbol should be displayed; and
- an alarm should be given.

The preset CPA/TCPA limits applied to target data derived from different sensors should be identical.

If the signal of a dangerous AIS target is not received for a set time:

- a lost target symbol should appear at the latest position and an alarm be given;
- the lost target symbol should disappear after the alarm has been acknowledged; and
- means to recover the data for a number of last acknowledged lost targets might be provided.

Preferably this function may also be applied to any AIS target within a certain distance.

An automatic display selection function may be provided to avoid the presentation of two target symbols for the same physical target. If target data from AIS and from radar plotting functions are available, then the activated AIS target symbol should be presented, if the automatic selection criteria are fulfilled, otherwise the respective symbols should be displayed separately. The operator should have the option to make reasonable changes to the default parameters of automatic selection criteria.

Means should be provided to display and acknowledge alarm messages from own AIS. Indication should be given if own AIS is out of service or switched off.

5.1.6 HUMAN INTERFACE

As far as practical, the user interface for operating, displaying and indicating AIS functions should be equivalent to the other relevant functions of the navigational aid.

5.2 AIS INSTALLATION AND INTEGRATION

This matter is dealt with in Chapter 11.

6 INTEGRATION & DISPLAY OF AIS INFORMATION ASHORE

It should be noted, as previously mentioned, a harmonised approach to display of AIS information is being taken by the IEC TC80 WG 13 for ship-borne use.

VTS, Harbour Authorities and others should take account of this when addressing the following points:

- Display on Radar
- Display on ECDIS
- Display on Dedicated Graphic Display
- Display of Navigation Warnings
- Display of Meteorological Warnings
- Display of Shipping Information

7 AIS INFORMATION TRANSFER & COMMUNICATION MODES

7.1 DATA TRANSFER WITH AIS

The AIS station normally operates in an autonomous and continuous mode using SOTDMA (Self Organizing Time Division Multiple Access) reports, regardless of whether the fitted vessel is operating in the open seas, coastal waters or on inland waterways. To work properly on the radio link there are also RATDMA (Random), ITDMA (Incremental), and FATDMA (Fixed) protocols. The main purpose of these different protocols is:

- RATDMA is used to access the radio link and randomly allocate a slot. It can also be used to initiate a more frequent update rate when i.e. changing course.
- ITDMA is used to allocate slots in the next minute and to prepare for SOTDMA slot map. For example, when the ship has to update at a faster rate i.e. when changing course.
- SOTDMA is the normally used protocol and allocates the slots three to seven frames ahead. It means that all other AIS' will have three to seven chances to receive the allocation of the ships using SOTDMA. This makes the radio link robust.
- FATDMA is reserved for use by AIS shore stations

The required VHF reports are essentially for short range, require a substantially increased data rate and must not suffer from interference. For this purpose two VHF frequencies in the maritime mobile band are utilized in parallel. The modulation method used is FM/GMSK (Frequency Modulation/Gaussian Minimum Shift Keying) due to its robustness, its discrimination possibilities, its bandwidth efficiency and its widespread application in mobile digital communications.

The AIS station communicates on two parallel VHF channels at the same time. Each minute of time on each channel is divided into 2250 slots. The 2250 slots constitute a frame and each frame is repeated every minute. These are accurately synchronized using GNSS time information as a first phase timing mechanism. They are able to operate using a secondary independent timing mechanism if required, which provides timing accuracy of better than 10 µs.

Each station determines its own transmission schedule (slot allocation), based upon data link traffic history and knowledge of future actions by other stations. A position report message from one AIS station fits into one of the 2250 time slots.

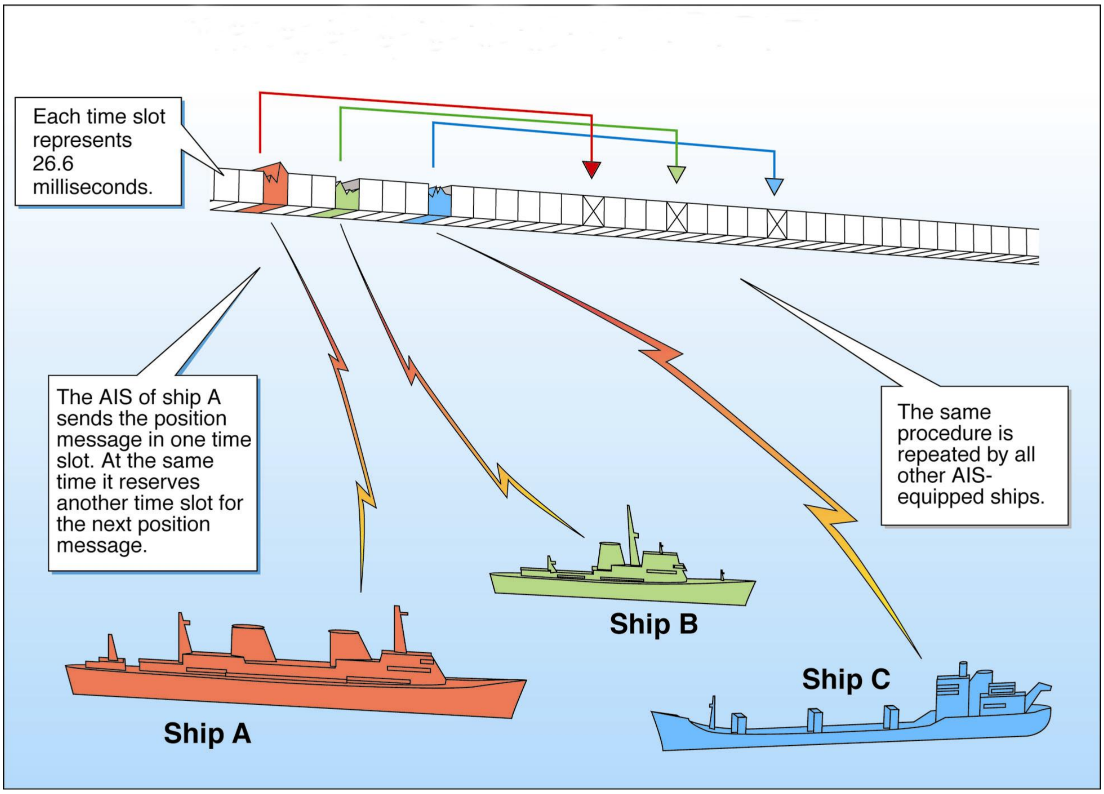


Figure 1: Principles of ITDMA

7.1.1 VHF DATA LINK (VDL) CAPACITY

AIS can use both 25 kHz and 12.5 kHz simplex channel bandwidths. When operating with either of these bandwidths, the resulting capacity is 2250 slots /minute at a transmission rate of 9600 bits per second.

When both AIS channels (AIS 1, AIS 2) are used the reporting capacity is 2 times 2250 i.e. 4500 slots /minute.

Because the system operates in the maritime VHF radio band, it is capable of communicating within “line of sight”. Should the number of AIS stations within the line of sight range of a receiving AIS station exceed the frame capacity in terms of reports per minute, the SOTDMA algorithm and the GMSK/FM modulation ensures that the effective radio cell range/size for each AIS station slowly decreases. Transmissions from AIS stations farthest away are suppressed, thus giving priority to those closer to the receiving station.

The overall effect is that, as a channel approaches an overloaded state, the TDMA algorithm produces a progressive reduction of the radio cell size. The effect is to drop AIS reports from vessels farthest from the centre of operations, while maintaining the integrity of the (more important) closer range reports.

However, when using 12.5 kHz channels the communication range is reduced. The size of the radio cell in the 12.5 kHz channel, in an overload situation, shrinks to approximately one half the size compared to that in the 25 kHz channel.

This effect has to be taken into consideration when planning 12.5 kHz channel areas.

7.2 REQUIRED UPDATE RATES

The IMO Performance Standards and the IMO liaison statement to ITU-R provide the type of data to be exchanged. The IALA VTS Committee studied this problem with regard to potential VTS/Ship Reporting System requirements. Considerations were based on current radar techniques, timing of consecutive DGNSS position fixes and finally, the worst-case scenario of peak traffic situations in the Singapore and Dover Straits.

Using a theoretical maximum VHF radio range of 40 NM, an estimate of about 3000 reports per minute was calculated for the Singapore Straits. A similar calculation for Dover Strait gave a requirement for about 2,500 reports per minute. On practical grounds, a figure of 2000 reports per minute was chosen as the maximum requirement together with the following update rates:

Class A ship-borne mobile equipment reporting intervals

Ship's Dynamic Conditions	Nominal Reporting Interval *
Ship at anchor or moored and not moving faster than 3 knots	3 minutes
Ship at anchor or moored and moving faster than 3 knots	10 seconds
Ship 0-14 knots	10 seconds
Ship 0-14 knots and changing course	$3^1/_3$ seconds
Ship 14-23 knots	6 seconds
Ship 14-23 knots and changing course	2 seconds
Ship > 23 knots	2 seconds
Ship > 23 knots and changing course	2 seconds

Table 2: Update intervals Class A Ship-borne Mobile Equipment (SME)

* In order to predict the turning rate and track when ships are altering course an increased update rate is needed. A rate that is three times faster than standard has been selected based on the required position accuracy.

Note 1: These values have been chosen to minimize unnecessary loading of the radio channels while maintaining compliance within the IMO AIS performance standards

Note 2: If the autonomous mode requires a higher reporting rate than the assigned mode, the Class A ship-borne mobile AIS station should use the autonomous mode.

Reporting intervals for equipment other than Class A ship-borne mobile equipment

Platform's Condition	Nominal Reporting Interval [1]
Class B Ship-borne Mobile Equipment not moving faster than 2 knots	3 minutes
Class B Ship-borne Mobile Equipment moving 2-14 knots	30 seconds
Class B Ship-borne Mobile Equipment moving 14-23 knots	15 seconds
Class B Ship-borne Mobile Equipment moving > 23 knots	5 seconds
Search and Rescue aircraft (airborne mobile equipment)	10 seconds
Aids to Navigation	3 minutes
AIS base station[(2)]	10 seconds

Table 3: Update intervals Class B Ship-borne Mobile Equipment (SME)

(1) In certain technical conditions related to synchronisation, a mobile station's reporting rate may increase to once every 2 seconds.
(2) The Base Station rate increases to once every $3^{1/3}$ seconds if the station detects that one or more stations are synchronising to it (the base station).

7.3 SHIP-BORNE INSTALLATIONS

The ship-borne AIS is designed to provide identification, navigational information and vessel's current manoeuvring information to other ships. Options include connection to external GNSS/DGNSS equipment and other sensor sources of navigational information from ship's equipment. Interfacing is in accordance with IEC 61162 series standards (see Figure 2).

Chapter 7 gives full details of the transmitted data included in AIS messages, and Chapter 8 gives the details of the messages.

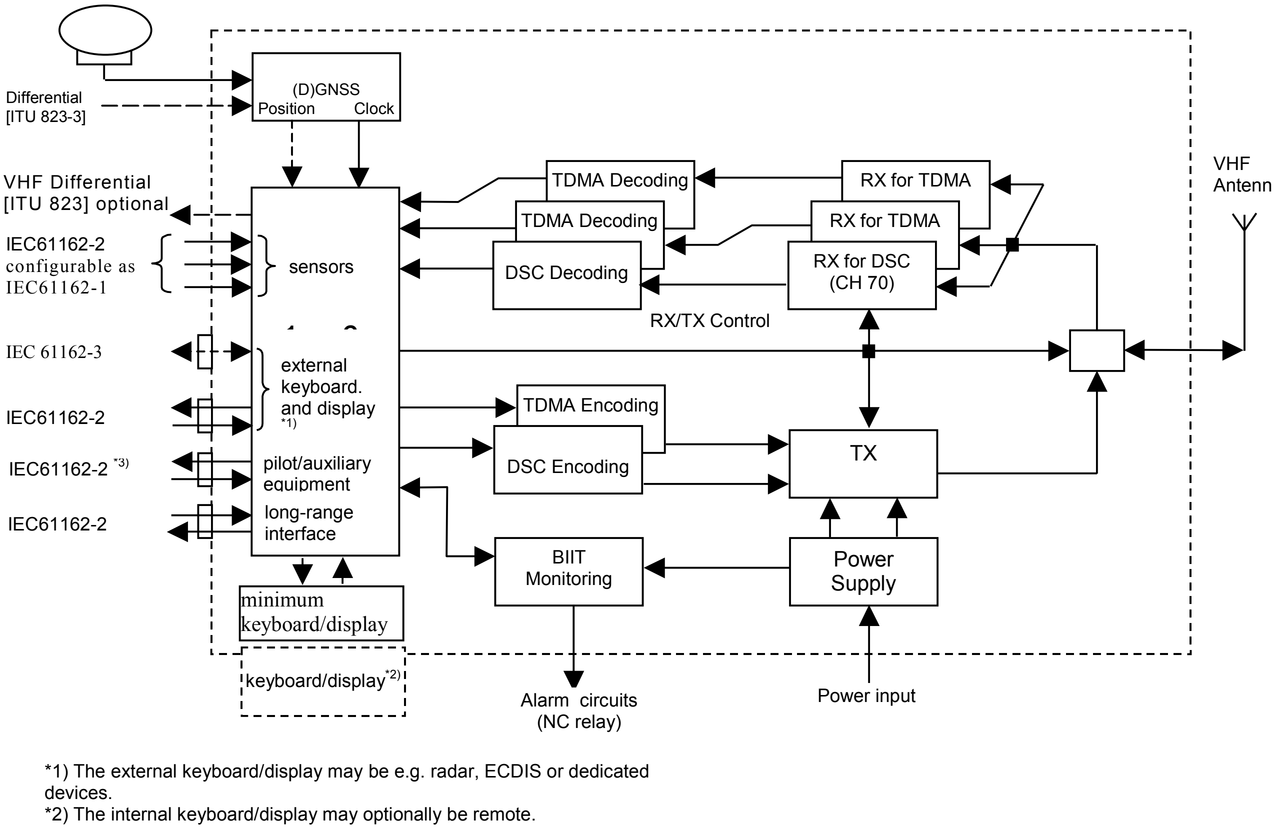


Figure 2: Schematic Diagram of Class "A" Ship-borne AIS Station

7.4 COMMUNICATIONS REQUIREMENTS

AIS must be able to operate autonomously in "ship-ship" mode, everywhere and at all times. Thus, the ship-borne AIS is required to simultaneously support both "ship-shore" and "ship-ship" modes when in a VTS or ship reporting area. To meet this requirement and mitigate the effects of radio frequency interference (since one channel may be jammed due to interference), ship-borne AIS stations are designed to operate on two frequency channels simultaneously.

The AIS standard provides for automatic channel switching (channel management using DSC and frequency-agile AIS stations) and for duplex as well as simplex channel operations.

7.4.1 RADIO FREQUENCY ALLOCATIONS

In response to a request from the IMO seeking global frequencies for AIS, the 1997 ITU World Radio Conference (WRC-97) designated two worldwide channels from the VHF maritime mobile band for this purpose. The channels are AIS 1 - 87B (161.975 MHz) and AIS 2 - 88B (162.025 MHz). Two channels were selected to increase capacity and mitigate RF interference. Again at the request of IMO, the ITU-R developed and approved a technical standard for AIS, Recommendation ITU-R M.1371-1.

The WRC-97 also provided for administrations to designate "regional frequency channels for AIS" where channels 87B and 88B were unavailable and, if necessary, to derive new Appendix S18 channels using Recommendation ITU-R M.1084-2 (simplex use of duplex channels and/or 12.5 kHz narrowband channels). WRC-97 further stated that "these regions should be as large as possible" for navigation safety purposes.

This requirement arose because some maritime nations experienced problems in releasing the WRC-97 designated channels for AIS and therefore needed separate regional frequencies for use in their areas.

However, because of the channel management and automatic switching techniques being employed, this will be largely transparent to the user and will have little impact on international shipping and the operation of AIS.

7.4.2 CHANNEL MANAGEMENT

WRC-97 and ITU-R M.1371-1 both specified that the two frequencies for AIS use on the high seas and any regional frequencies designated by administrations are to be from within the VHF maritime band as defined in Appendix S18 of the International Radio Regulations. As mentioned, the WRC-97 also provided for the use of 12.5 kHz narrowband for AIS where administrations might need it due to lack of channel availability.

In order to facilitate the full use of the frequency band and to enable automatic frequency channel switching for ships and shore stations, the AIS standard utilises Digital Selective Calling (DSC). The standard refers to this as *"channel management."* The new AIS standard also provides for TDMA channel management via DSC and limited polling via DSC.

AIS channel switching is accomplished when the shore stations switch ships' AIS stations to VTS/AIS designated working frequencies (or regional frequencies). Switching of frequencies can be done in several ways; these include automatic switching by the shore base stations, or manual switching by the AIS operator on the ship. In addition, switching from shore can be performed by a VTS base station using SOTDMA protocols or by a GMDSS A1 Area station using DSC.

7.5 LONG RANGE MODE

7.5.1 OVERVIEW

The IMO performance standard for AIS requires that the equipment should function *"as a means for littoral States to obtain information about a ship or its cargo"* when a vessel is operating in that State's area of maritime responsibility. An AIS long-range communications and reporting mode is required to satisfy this function and to assist administrations in meeting their responsibilities for wide area or offshore monitoring of shipping traffic.

The objective of maritime administrations is to ensure that its waterways and environment are safe, and to provide an economically effective environment for shipping traffic. This task is met by enforcing appropriate national and international regulations that govern how ships enter and operate in the territorial waters of a country. AIS, in conjunction with a VTS Centre (or another shore authority), can provide an excellent tool to achieve these objectives over the short ranges provided by the underlying VHF transmission system. However, AIS, in combination with a long-range communication medium, also provides an excellent tool to meet the long-range ship tracking and monitoring requirements of a VTS or shore authority

The reasons that an administration would require to monitor vessel traffic in a wide area or offshore include the safety of navigation, assistance with search and rescue (SAR), resource exploration and exploitation and environmental protection. Such offshore areas include the continental shelf and economic exclusion zones (EEZ). In certain areas tankers must move in strict conformance with established Tanker Exclusion Zone (TEZ) regulations. Examples are:

- The TEZ on the West Coast of Canada.
- The mandatory route for larger tankers from North Hinder to the German Bight and vice versa as described in IMO document MSC 67/22/Add 1 - Annex 11.
- The two ship reporting systems in Australia - AUSREP and REEFREP. Both have been adopted by IMO and could be potential candidates for implementing the long-range application.

Adherence to the regulations pertaining to such cases must be monitored. Currently, voluntary and mandatory ship reporting schemes are approved by IMO and specific reporting formats are as laid down in IMO resolution A.851 (20) ‘General principles for ship reporting systems and ship reporting requirements, including guidelines for reporting incidents involving dangerous goods, harmful substances and/or marine pollutants’.

The long-range mode of AIS provides an effective alternative or complementary tool to allow ships to comply effectively with these rules.

NOTE:
The recent developments with regard to the accelerated implementation of AIS, and in particular a means of providing longer range information, could affect the way in which long range reporting is used and implemented.

7.5.2 LONG-RANGE REPORTING FORMAT

Table 4 describes the long-range functions, which are available as standard in the AIS. If the Function Identifier ID has the indication ‘Not available’, the information is not available in the standard AIS system at this moment. It should be possible to gather this type of information from an external source.

7.5.3 PLANNING REQUIREMENTS FOR LONG-RANGE AIS

When contemplating the use of AIS for their long-range ship monitoring function administrations are encouraged to take into account the following planning parameters.

- The long-range application of AIS must operate in parallel with the VDL. Long-range operation will not be continuous. The long-range system will not be designed for constructing and maintaining a real time traffic image on a large area. Position updates will be in the order of 2-4 times per hour (maximum). Some applications may require an update just twice a day. Consequently, the long-range application presents a low traffic workload to the communication system or the AIS stations and will not interfere with the normal VDL operation.
- The long-range mode will be initiated by a general all-ships broadcast message directed to a specific, geographically defined area. Once a specific ship has been identified and captured in the appropriate VTS database, it will subsequently be polled by addressed interrogations as defined in the applicable AIS specifications. When responding, ships will use the standard message formats such as position reports and voyage-related data.

ID	Function	Remarks
A	Ship name / Call sign / MMSI / IMO number	MMSI number shall be used as a flag identifier
B	Date and time in UTC	Time of composition of message shall be given in UTC only. Day of month, hours and minutes
C	Position	WGS84; Latitude / Longitude degrees and minutes
D		Not available
E	Course	Course over ground (COG) in degrees
F	Speed	Speed over ground (SOG) in knots and 1/10 knots
G, H		Not available
I	Destination / ETA	At masters discretion; ETA time format see B
J, K, L, M, N		Not available
O	Draught	Actual maximum draught in 1/10 of meters
P	Ship / Cargo	As defined in AIS message 5
Q, R, S, T		Not available
U	Length / Beam / Type	Length and beam in meters Type as defined in AIS message 5, tonnage not available
V		Not available
W	Number of persons on board	
X,Y		Not available
Z		Not used

Table 4: Long-Range Message Content

8 AIS MESSAGES

8.1 MESSAGE TYPES AND FORMATS

The different information message types classified as “static”, “dynamic” or “voyage related” are used as AIS messages and are valid for different time periods, thus requiring different update rates. "Short safety related messages" are sent as required and are independent of timing. Ship’s speed and manoeuvring status are used as the means of governing update rates for “dynamic” messages and ensuring the appropriate levels of positional accuracy for ship tracking. A similar process is applied to the content of ship information messages (“static” and “voyage related”) to ensure that the more important message data being communicated is not encumbered with static or low priority information.

“Static” information is entered into the AIS on installation and need only be changed if the ship changes its name or undergoes a major conversion from one ship type to another. “Dynamic” information is automatically updated from the ship sensors connected to AIS. “Voyage related” information is manually entered and updated during the voyage. The ship information to be provided within the various AIS messages includes:

• ***Static information***:	*8.1.1.1.1.1.1.1 Every 6 minutes and on request by competent authority*
MMSI	Maritime Mobile Service Identity. Set on installation - note that this might need amending if the ship changes ownership
Call sign and name	Set on installation – note that this might need amending if the ship changes ownership
IMO Number	Set on installation
Length and beam	Set on installation or if changed
Type of ship	Select from pre-installed list (see Table 11)
Location of position fixing antenna	Set on installation or may be changed for bi-directional vessels or those fitted with multiple position fix antennae
Height over keel	Set on installation; (aft of bow and port/starboard of centreline). Transmitted at Master’s discretion and on request by a competent authority
• ***Dynamic information:***	*Dependent on speed and course alteration (see Tables 2 & 3)*
Ship's position with accuracy indication and integrity status	Automatically updated from the position sensor connected to the AIS. The accuracy indication is for better or worse than 10 m.
Position Time stamp in UTC	Automatically updated from ship's main position sensor connected to AIS. (e.g. GPS)
Course over ground (COG)	Automatically updated from ship's main position sensor connected to the AIS, provided that sensor calculates COG. (This information might not be available)
Speed over ground (SOG)	Automatically updated from the position sensor connected to the AIS, provided that the sensor calculates SOG (This information might not be available).
Heading	Automatically updated from the ship's heading sensor connected to the AIS.

Navigational status	Navigational status information has to be manually entered by the OOW and changed, as necessary, for example: - underway by engines - at anchor - not under command (NUC) - restricted in ability to manoeuvre (RIATM) - moored - constrained by draught - aground - engaged in fishing - underway by sail In practice, since all these relate to the COLREGS, any change that is needed could be undertaken at the same time that the lights or shapes were changed.
Rate of turn (ROT)	Automatically updated from the ship's ROT sensor or derived from the gyrocompass. (This information might not be available).
<u>Note:</u> Provision must be made for inputs from external sensors giving additional information where available (e.g. angle of heel, pitch and roll etc)	

• **Voyage related information:**	*Every 6 minutes, when data is amended or on request*
Ship's draught	To be manually entered at the start of the voyage using the maximum draft for the voyage and amended as required; e.g. after de-ballasting prior to port entry.
Hazardous cargo (type)	As required by competent authority. To be manually entered at the start of the voyage confirming whether or not hazardous cargo is being carried, namely: - DG Dangerous Goods - HS Harmful Substances - MP Marine Pollutants Indications of quantities are not required.
Destination and ETA	At Master's discretion. To be manually entered at the start of the voyage and kept up to date as necessary.
Route plan (waypoints)	At Master's discretion, and upon interrogation by a competent authority only. Textual description, to be manually entered at the start of the voyage and updated if required.
Number of persons onboard	Including crew. At Master's discretion and on request by a competent authority only.

Table 5: Static, Dynamic, Voyage Related, Information

Short safety-related messages:	*As required*
Free format short text messages would be manually entered and addressed either to a specific addressee, a selected group of addressees or broadcast to all ships and shore stations.	

Table 6: Short Safety-related messages

8.2 STANDARD MESSAGE FORMATS

The information to be transferred between ships and between ship and shore is packaged into a series of standard formatted messages and transmitted at pre-determined intervals, when their content data is amended or on request by a competent authority. There are some 22 different types of messages included in the AIS Technical Standard, ITU-R M.1371-1 which not only contain the transmitted information but serve various other system or data link functions including message acknowledgement, interrogation, assignments or management commands.

Further description of these message types and functions is included in Part 2 - Technical, with full details of message structures in ITU-R M.1371-1. The following listing (Table 7) shows the primary message grouping of interest to the operators of AIS and indicates the operational modes associated with each message (AU = autonomous, AS = assigned, IN = polling/interrogation). Further description of the more relevant messages is provided in the following paragraphs:

Message Identifiers	Description	Operation Mode
1,2,3	Position Report - scheduled, assigned or response to polling	AU,AS,
4	Base Station Report – position, UTC/date and current slot number	AS
5	Static and Voyage Related Data - Class A SME	AU,AS
6,7,8	Binary Messages – addressed, acknowledge or broadcast	AU,AS,IN
9	Standard SAR Aircraft Position Report	AU,AS
10,11	UTC/Date - enquiry and response	AS,IN
12,13,14	Safety Related Message – addressed, acknowledge or broadcast	AS,IN
15	Interrogation – request for specific message type	AU,AS,IN
16	Assignment Mode Command - by competent authority	AS
17	DGNSS Broadcast Binary Message	AS
18,19	Class B SME Position Report – standard and extended reports	AU,AS
20	Data Link Management – reserve slots for Base Stations	AS
21	Aids to Navigation Report – position and status report	AU,AS,IN
22	Channel Management	AS

Table 7: Primary Message Types (in groupings) and Operating Modes

8.2.1 POSITION REPORT (MESSAGES 1,2 OR 3)

The Position Report message, which contains primarily dynamic data and would normally constitute the priority message, is shown below at Table 8.

Parameter	Description
MSG ID	Identifier for this message (1, 2 or 3)
Repeat Indicator	0-3. Used by the repeater to indicate how many times the message has been repeated; default = 0; 3 = do not repeat again.
User ID	MMSI number (Unit serial number as substitute)
Navigational Status	0 = underway using engine; 1 = at anchor; 2 = not under command; 3 = restricted manoeuvrability; 4 = constrained by draught; 5 = moored; 6 = aground; 7 = engaged in fishing; 8 = underway sailing; 9 = (reserved for HSC category); 10 = (reserved for WIG category); 15=Default
Rate of Turn	±708 degrees/min. (-128 indicates not available which is the default) (see Table 23
SOG	Speed Over Ground in 1/10 knot steps (0 -102.2 knots) 1023 = not available; 1022 = 102.2 knots or higher
Position Accuracy	1 = High (<10m. Differential mode of e.g. DGNSS receiver); 0 = Low (> 10m; Autonomous mode of e.g. GNSS receiver or other electronic position fixing device); default = 0
Longitude	Longitude in 1/10 000 minute (±180 degrees, East = positive, West = negative); 181 degrees = not available = default
Latitude	Latitude in 1/10 000 minute (±90 degrees, North = positive, South = negative); 91 degrees = not available = default
COG	Course Over Ground in 1/10 degree (0 – 3599); 3600 = not available = default
True Heading	Degrees (0-359) (511 indicates not available = default

Parameter	Description
Time stamp	UTC second when the report was generated (0-59,) or 60 - if time stamp is not available which should also be the default) or 61 - if the electronic position fixing system is in manual input mode; or 62 -if the positioning systems is in estimated [dead reckoning] mode, or 63 - if the positioning system is inoperative.
Reserved for regional applications	Reserved for definition by a competent regional authority. Shall be set to 0, if not used for regional application.
RAIM Flag	(Receiver Autonomous Integrity Monitoring) flag of electronic position fixing device; 0= RAIM not in use = default; 1 = RAIM in use.

Table 8: Position Report message

8.2.2 BASE STATION REPORT

This message is used for reporting UTC time and date and, at the same time, position. A Base Station uses Message 4 in its periodical transmissions, while a Mobile Station outputs Message 11 only in response to interrogation by Message 10.

Parameter	Description
Message ID	Identifier for this message (4, 11) 4 = UTC and position report from base station; 11 = UTC and position response from mobile station.
Repeat Indicator	Used by the repeater to indicate how many times a message has been repeated. 0 - 3; default = 0; 3 = do not repeat again.
User ID	MMSI number
UTC year	1 - 9999; 0 = UTC year not available = default.
UTC month	1 - 12 ; 0 = UTC month not available = default
UTC day	1 - 31 ; 0 = UTC day not available = default.
UTC hour	0 - 23 ; 24 = UTC hour not available = default
UTC minute	0 - 59 ; 60 = UTC minute not available = default;
UTC second	0 - 59; 60 = UTC second not available = default.
Position accuracy	1= high (<10 m; Differential Mode of e.g. DGNSS receiver) 0= low (>10 m; Autonomous Mode of e.g. GNSS receiver or of other electronic position fixing device); default = 0
Longitude	Longitude in 1/10 000 minute (±180degrees, East = positive, West = negative); 181 degrees = not available = default
Latitude	Latitude in 1/10 000 minute (±90degrees, North = positive, South = negative); 91 degrees = not available = default
Type of Electronic Position Fixing Device	use of differential corrections is defined by field 'position accuracy' above; 0 = Undefined (default), 1 = GPS, 2 = GLONASS, 3 = Combined GPS/GLONASS, 4 = Loran-C, 5 = Chayka, 6 = Integrated Navigation System, 7 = surveyed, 8 - 15 = not used;
RAIM-Flag	Receiver Autonomous Integrity Monitoring (RAIM) flag of electronic position fixing device; 0 = RAIM not in use = default; 1 = RAIM in use)
Communication State	SOTDMA/ITDMA Communication State

Table 9: Base Station Report (message 1, 2, & 3, Content and Format)

8.2.3 Static and Voyage Related Data

This message is only used by Class A ship-borne mobile equipment when reporting static or voyage related data. As well as being transmitted routinely at 6-minute intervals, or in response to a polling request, this message will also be sent immediately after any parameter value has been changed.

Parameter	Description
Message ID	Identifier for this message (5)
Repeat Indicator	Used by the repeater to indicate how many times a message has been repeated. 0 - 3; default = 0; 3 = do not repeat again.
User ID	MMSI number
AIS Version Indicator	0 = Station compliant with AIS Edition 0 (Rec. ITU-R M.1371-1); 1 - 3 = Station compliant with future AIS Editions 1, 2, and 3.
IMO number	1 – 999999999 ; 0 = not available = default
Call sign	7 x 6 bit ASCII characters, "@@@@@@@" = not available = default.
Name (Ship)	Maximum 20 characters 6 bit ASCII, "@@@@@@@@@@@@@@@@@@@@"=not available = default.
Type of ship and cargo type	0 = not available or no ship = default; 1 - 99 = as defined in Table 11; 100 - 199 = reserved, for regional use; 200 - 255 = reserved for future use.
Dimension/Reference for Position	Reference point for reported position; Also indicates the dimension of ship in metres (see Figure 3)
Type of Electronic Position Fixing Device	0 = Undefined (default); 1 = GPS, 2 = GLONASS, 3 = Combined GPS/GLONASS, 4 = Loran-C, 5 = Chayka, 6 = Integrated Navigation System, 7 = surveyed, 8 - 15 = not used
ETA	Estimated Time of Arrival; MMDDHHMM UTC
	month; 1 - 12; 0 = not available = default;
	day; 1 - 31; 0 = not available = default;
	hour; 0 - 23; 24 = not available = default;
	minute; 0 - 59; 60 = not available = default
Maximum Present Static Draught	in 1/10 m; 255 = draught *25.5 m* or greater, 0 = not available = default; in accordance with IMO Resolution A.851
Destination	Maximum 20 characters using 6-bit ASCII; "@@@@@@@@@@@@@@@@@@@@" = not available.
DTE	Data terminal ready (0 = available 1 = not available = default)

Table 10: Ship Static and Voyage Related Data Report (Content and Format)

Identifiers Used by Ships to Report Their Type*	
First digit	Second digit
0 – Not used	0–All ships of this type
1 – Reserved for future use	1– Carrying DG, HS, or MP IMO hazard or pollutant category A
2 – WIG	2– Carrying DG, HS, or MP IMO hazard or pollutant category B
3 – See Table 12 below	3– Carrying DG, HS, or MP IMO hazard or pollutant category C
4 – HSC	4– Carrying DG, HS, or MP IMO hazard or pollutant category D
5 – See Table 12 below	5– reserved for future use
6– Passenger ships	6- reserved for future use
7– Cargo ships	7–reserved for future use
8– Tankers	8 – reserved for future use
9– Other types of ship	9 – No additional Information

* This formatter requires two digits: The first is any digit from the column on the left, the second is any digit from the column on the right

DG = Dangerous Goods; HS = Harmful Substances; MP = Marine Pollutants

Table 11: Ship Type Identifiers

Identifier No.		**Identifiers Used by Special Craft to Report Their Type**
First Digit	Second Digit	
5	0	Pilot vessel
5	1	Search and rescue vessels
5	2	Tugs
5	3	Port tenders
5	4	Vessels with anti-pollution facilities or equipment
5	5	Law enforcement vessels
5	6	Spare – for assignments to local vessels
5	7	Spare – for assignments to local vessels
5	8	Medical transports (as defined in the 1949 Geneva Conventions and Additional Protocols)
5	9	Ships according to Resolution No 18 (Mob-83)

Table 12: Special Craft

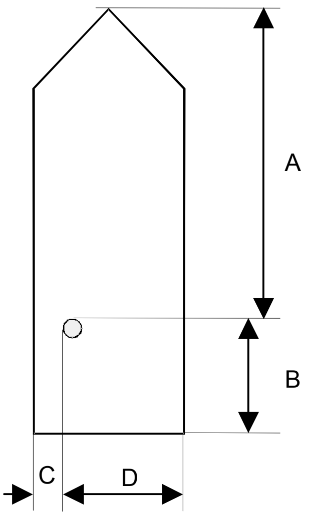
Identifier No.		**Identifiers Used by Other Ships to Report Their Type**
First Digit	Second Digit	
3	0	Fishing
3	1	Towing
3	2	Towing and length of the tow exceeds 200 m or breadth exceeds 25 m
3	3	Engaged in dredging or underwater operations
3	4	Engaged in diving operations
3	5	Engaged in military operations
3	6	Sailing
3	7	Pleasure Craft
3	8	Reserved for future use
3	9	Reserved for future use

Table 13: Other Ships

8.2.4 EXTENDED STATIC AND VOYAGE RELATED DATA

Additional information, particularly height over keel (static) and number of persons on board [pitch and roll](voyage related) can be provided through the use of international function identifier applications.

8.2.5 SHIP DIMENSIONS AND REFERENCE FOR POSITION



	Distance in meters
3 A	0 - 511; 511 = 511m or greater
B	0 - 511; 511 = 511m or greater
C	0 - 63; 63 = 63 m or greater
D	0 - 63; 63 = 63 m or greater

Reference point of reported position not available, but dimensions of ship are available: A = C = 0 and B ≠ 0 and D ≠ 0.
Neither reference point of reported position nor dimensions of ship available: A = B = C = D = 0 (=default)

Figure 3: Vessel Dimensions and Reference for Position

8.2.6 BINARY MESSAGES

Binary messages can be addressed to a particular mobile or shore station or broadcast to all stations in the area. They are also used to acknowledge Short Safety Related Messages, where necessary. Addressed Binary Messages are variable in length depending on the size of the binary data to be sent and can be between 1 and 5 message slots. In effect, this means that up to 160 6-bit ASCII characters can be included in the text of each message

8.2.7 SHORT SAFETY RELATED MESSAGES

Short Safety Related Messages, are a category of Binary Messages and can be either "Addressed", to a specified destination (MMSI) or "Broadcast" to all AIS fitted ships in the area. Messages can include up to 160 x 6-bit ASCII character in the text of the message but should be kept as short as possible. They can be fixed or free format text messages and their content should be relevant to the safety of navigation, e.g. an iceberg sighted or a buoy not on station.

Operator acknowledgement may be requested by a text message in which case a Binary Acknowledge Message will be used.

Short Safety Related Messages are an additional means to broadcast maritime safety information. Their usage does not remove any of the requirements of the Global Maritime Distress Safety System (GMDSS).

8.3 NON STANDARD MESSAGES

8.3.1 SAR AIRCRAFT POSITION REPORT

This message (9) is used for a standard position report from aircraft involved in SAR operations instead of Messages 1, 2, or 3. Stations other than aircraft involved in SAR operations should not use this message. The default reporting interval for this message is 10 seconds.

Parameter	Description
Message ID	Identifier for message (9); always 9
Repeat Indicator	Used by the repeater to indicate how many times a message has been repeated. 0 - 3; default = 0; 3 = do not repeat again.
User ID	MMSI number
Altitude (GNSS)	Altitude (derived from GNSS) expressed in metres (0 – 4094 metres) 4095 = not available, 4094 = 4094 metres or higher
SOG	Speed over ground in knot steps (0-1022 knots) 1023 = not available, 1022 = 1022 knots or higher
Position accuracy	1 = high (< 10 m; Differential Mode of e.g. DGNSS receiver) 0 = low (> 10 m; Autonomous Mode of e. g. GNSS receiver or of other Electronic Position Fixing Device); default = 0
Longitude	Longitude in 1/10 000 min (± 180 degrees, East = positive, West = negative). 181 degrees (6791AC0 hex)= not available = default
Latitude	Latitude in 1/10 000 min (± 90 degrees, North = positive, South = negative, 91 degrees (3412140 hex) = not available = default)
COG	Course over ground in 1/10□ (0-3599). 3600 (E10 hex) = not available = default; 3601 – 4095 should not be used
Time stamp	UTC second when the report was generated (0-59) or 60 if time stamp is not available, = default, or 62 if Electronic Position Fixing System operates in estimated (dead reckoning) mode, or 61 if positioning system is in manual input mode or 63 if the positioning system is inoperative.
Reserved for regional applications	Reserved for definition by a competent regional authority. Should be set to zero, if not used for any regional application. Regional applications should not use zero.
DTE	Data terminal ready (0 = available 1 = not available = default)
RAIM-Flag	RAIM (Receiver Autonomous Integrity Monitoring) flag of Electronic Position Fixing Device; 0 = RAIM not in use = default; 1 = RAIM in use)
Communication State	SOTDMA/ITDMA status.

Table 14: SAR Aircraft Position Report

8.3.2 DGNSS BROADCAST MESSAGE

Broadcasting differential GPS corrections from ashore or correlating the ship's position on board by DGPS connection via the SOTDMA data link to all vessel AIS stations enables those recipients to navigate with differential accuracy. The position broadcast from the vessels will have differential accuracy, the built in functionality using the best available correction available at that instant.

This type of system could serve as the primary system in a port or VTS area or as a back up for the IALA DGPS MF Beacon System. For full compatibility with the IALA DGPS MF Beacon System it should be provided with capabilities for integrity monitoring and for transfer of that information to the user.

8.3.3 DGNSS BROADCAST BINARY MESSAGE

This message (17) is transmitted by a base station, which is connected to a DGNSS reference source, and configured to provide DGNSS data to receiving stations. The contents of the data should be in accordance with ITU-R M.823-2, excluding preamble and parity formatting.

Parameter	Description
Message ID	Identifier for message (17); always 17
Repeat Indicator	Used by the repeater to indicate how many times a message has been repeated. 0 - 3; default = 0; 3 = do not repeat again.
Source ID	MMSI of the base station.
Spare	Spare. Should be set to zero.
Longitude	Surveyed Longitude of DGNSS reference station in 1/10 min (±180 degrees, East = positive, West = negative). If interrogated and differential correction service not available, the longitude should be set to 181°.
Latitude	Surveyed Latitude of DGNSS reference station in 1/10 min (±90 degrees; North = positive, South = negative). If interrogated and differential correction service not available, the latitude should be set to 91°.
Data	Differential Correction data (drawn from Recommendation ITU-R M.823-2). If interrogated and differential correction service not available, the data field should remain empty (zero bits). This should be interpreted by the recipient as DGNSS Data Words set to zero.

Table 15: GNSS Broadcast Binary Message

8.3.4 AID TO NAVIGATION MESSAGE

The main functions of aids to navigation (AtoN) such as Racons, buoys, beacons and lights are to mark the location of reference points and to identify and mark hazards. However, suitably equipped, they could provide additional information of a meteorological and/or oceanographic nature of benefit to the mariner. In addition, information on the operational status of the aid, which is of value both to the mariner and the service provider, could be provided.

Through AIS, it is now possible to have an AtoN site transmit its identity, its state of "health" and other information such as real time tidal height, tidal stream and local weather to surrounding ships or back to the shore authority. Buoys, which can transmit an accurate position (perhaps based on the DGPS corrections arriving on the SOTDMA data link, described earlier), can be closely monitored to ensure that they are "on station".

The information received ashore via the data link to the AtoN fitted with an AIS station can not only be used for performance monitoring but also for remotely changing a AtoN parameter/s or switching on back-up equipment at the AtoN site.

8.3.4.1 AID TO NAVIGATION REPORT MESSAGE

An AIS station mounted on an Aid-to-Navigation uses message number 21. The message should be transmitted autonomously at a reporting rate of once every three (3) minutes or it may be assigned another reporting rate by an Assigned Mode Command (Message 16) via the VHF data link, or by an external command. It will also be programmed to transmit immediately after any parameter value changes.

Parameter	Description
Message ID	Identifier for this message (21)
Repeat Indicator	Used by the repeater to indicate how many times a message has been repeated. 0 - 3; default = 0; 3 = do not repeat any more.
ID	MMSI number
Type of Aid-to-Navigation	0 = not available = default; refer to appropriate definition set up by IALA.
Name of Aid-to-Navigation	Maximum 20 characters 6 bit ASCII, "@@@@@@@@@@@@@@@@@@@@" = not available = default. The name of the Aid-to-Navigation may be extended by the parameter "Name of Aid-to-Navigation Extension" below.
Position accuracy	1 = high (< 10 m; Differential Mode of e.g. DGNSS receiver) 0 = low (> 10 m; Autonomous Mode of e.g. GNSS receiver or of other Electronic Position Fixing Device); Default = 0
Longitude	Longitude in 1/10 000 min of position of Aid-to-Navigation (±180 degrees, East = positive, West = negative. 181 degrees (6791AC0 hex) = not available = default)
Latitude	Latitude in 1/10 000 min of Aids-to-Navigation (±90 degrees, North = positive, South = negative, 91 degrees (3412140 hex) = not available = default)
Dimension/Reference for Position	Reference point for reported position; also indicates the dimension of Aid-to-Navigation in metres, if relevant (1).
Type of Electronic Position Fixing Device	0 = Undefined (default); 1 = GPS, 2 = GLONASS, 3 = Combined GPS/GLONASS, 4 = Loran-C, 5 = Chayka, 6 = Integrated Navigation System, 7 = surveyed. For fixed AtoNs and vitual/synthetic AtoNs, the surveyed position should be used. The accurate position enhances its function as a radar reference target. 8 – 15 = not used.
Time Stamp	UTC second when the report was generated by the EPFS (0 –59,

Parameter	Description
	or 60 if time stamp is not available, which should also be the default value, or 61 if positioning system is in manual input mode, or 62 if Electronic Position Fixing System operates in estimated (dead reckoning) mode, or 63 if the positioning system is inoperative)
Off-Position Indicator	For floating Aids-to-Navigation, only: 0 = on position; 1 = off position; NOTE – This flag should only be considered valid by receiving station, if the Aid-to-Navigation is a floating aid, and if Time Stamp is equal to or below 59. For floating AtoN the guard zone parameters should be set on installation.
Reserved for regional or local application	Reserved for definition by a competent regional or local authority. Should be set to zero, if not used for any regional or local application. Regional applications should not use zero.
RAIM-Flag	RAIM (Receiver Autonomous Integrity Monitoring) flag of Electronic Position Fixing Device; 0 = RAIM not in use = default; 1 = RAIM in use)
Virtual AtoN Flag	0 = default = real A to N at indicated position; 1 = no AtoN = ATON does not physically exist, may only be transmitted from an AIS station nearby under the direction of a competent authority. (2)
Assigned Mode Flag	0 = Station operating in autonomous and continuous mode =default 1 = Station operating in assigned mode
Spare	Spare. Not used. Should be set to zero.
Name of Aid-to-Navigation Extension	This parameter of up to 14 additional 6-bit-ASCII characters for a 2-slot message may be combined with the parameter “Name of Aid-to-Navigation” at the end of that parameter, when more than 20 characters are needed for the Name of the Aid-to-Navigation. This parameter should be omitted when no more than 20 characters for the name of the A-to-N are needed in total. Only the required number of characters should be transmitted, i. e. no @-character should be used.
Spare	Spare. Used only when parameter “Name of Aid-to-Navigation Extension” is used. Should be set to zero. The number of spare bits should be adjusted in order to observe byte boundaries.

Table 16: Aid-to-Navigation Report Message

Footnotes:

(1) When using Figure 3 for an aid-to-Navigation, the following should be observed:

- For a fixed Aid-to-Navigation, virtual and synthetic A-to-Ns, and for off-shore structures, the orientation established by the dimension A should point to true north.
- For floating aids larger than 2 m * 2 m the dimensions of the Aids to Navigation should always be given approximated to a square, i.e. the dimensions should always be as follows A=B=C=D≠0. (This is due to the fact, that the orientation of the floating Aid to Navigation is not transmitted. The reference point for reported position is in the centre of the square.)
- A=B=C=D=1 should indicate objects (fixed or floating) smaller than or equal to 2m * 2m. (The reference point for reported position is in the centre of the square.)

(2) When transmitting virtual/synthetic Aids to Navigation information, i.e. the virtual/synthetic Aids to Navigation Target Flag is set to one (1), the dimensions should be set to A=B=C=D=0 (default). This should also be the case, when transmitting “reference point“ information

8.4 INTERNATIONAL APPLICATION IDENTIFIER (IAI)

8.4.1 Binary Messages and Functional Identifiers

AIS allows the transfer of Binary Messages via the VDL as a means of communication for external applications as specified in ITU-R M.1371-1.

Binary messages can be broadcast (Message 8) in such a way that every receiver within the VHF range will receive them, and they can be addressed (Message 6) to one particular receiving station by using the MMSI of the recipient. The latter situation will result in a Binary Acknowledgement (Message 7) to confirm that the addressed binary message was received.
All binary messages are composed by an external application on the transmission side and can only be used by the same external application connected to the AIS on the receiver side.
The general set-up of the use of binary messages is as follows:

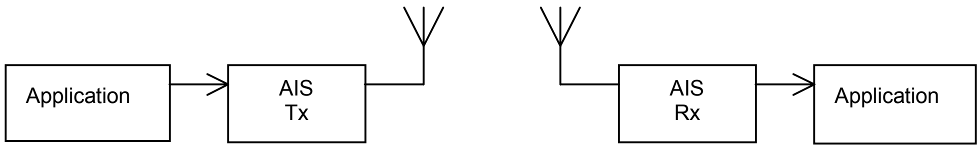


Figure 4

To distinguish between the different types of applications the following 'Application Identifier' header will be used as part of the binary data stream, consisting of:

- Designated Area Code (DAC)
- Function Identifier (FI)

Application Identifier

The 'Binary Data' field in both messages 6 and 8 looks as follows:

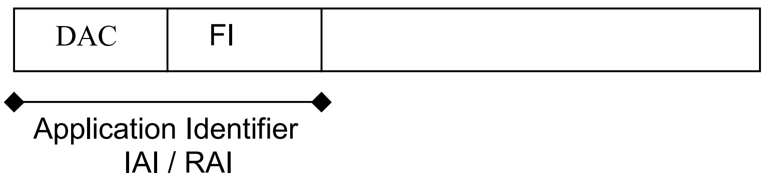


Figure 5

Applications for binary messages can be defined as international applications, which can be used by groups of users worldwide (International Branch). The DAC identifies the international branch of applications if its value is 001 and in combination with the FI it is called the International Application Identifier (IAI). Examples of international applications are: the transfer of VTS targets or number of persons onboard.
It is possible to define local or regional applications, which can be used by systems in a limited area or for a specially defined group of users. In this case the DAC identifies the regional branch of applications if its value is in the range between 001 and 999. In combination with the FI, it is called the Regional Application Identifier (RAI). DAC identifies a certain region or country as given by the Maritime Identification Digits (MID), as defined by ITU-R, which are the leading three digits of the MMSI. An

example of a regional application can be: sending specifically formatted messages to service vessels e.g. tugboats, in one particular port or country.
The DAC value of 000 is reserved for test purposes only. Values between 1000 and 1023 are reserved for future expansions of general capabilities.
The FI identifies the application itself. Each branch, international and each region, has 64 different identifiers available for specific applications. Each branch can group its 64 identifiers into specific categories of applications.
For the IAI the following groups have been defined:

- General Usage (Gen)
- Vessel Traffic Services (VTS)
- Aids-to Navigation (A-to-N)
- Search and Rescue (SAR)

The allocation and maintenance of function identifiers as part of the IAI, will be done by IALA in accordance with ITU-R M.1371-1 recommendation 3, which will also publish them and submit them to IMO and ITU.

For the Regional Application Identifier (RAI) at least two groups must be defined:

- Regional or national public applications
- Regional or national private organisations applications

A local competent authority located in this DAC, and following the guidelines as described in the ITU-R Recommendation M.1371-1, will do the allocation and maintenance of function identifiers as part of the RAI.

Binary messages can occupy 1 to 5 slots, depending on the amount of application specific data and are defined as follows (two numbers are given: first in data bytes, second if the binary message is used for sending 6-bit ASCII characters):

Number of slots	Addressed Binary Message (Message 6)	Binary Broadcast Message (Message 8)
1	8 / 8	12 / 14
2	36 / 46	40 / 51
3	64 / 83	68 / 88
4	92 / 120	96 / 126
5	117 / 158	121 / 163

Table 17

The difference between the available capacities is due to the MMSI addressing of the recipient in case of addressed messages.
It is recommended that any application minimise the use of slots by limiting the number of binary data bytes. The throughput time of binary messages is strongly dependent on the required number of subsequent slots to be used.

The use of binary messages is dependent on the availability of applications external to the AIS stations. The binary messages are transparent to the AIS itself. To determine the availability of applications of a station, an addressed binary message with International Function Message 3 (Capability Interrogation), can be sent by a ship or base station. This must be done for both the international branch and the regional branch separately. The reply is a binary message to the requesting station with International Message 4: 'Capability Reply', containing a list of all applications of the requested area (international or regional). When no external device is connected to the AIS station, no response will be given. After this procedure the available applications can be used. The external unit will neglect all other applications.

Function Identifiers (FI) allow for the operation of several applications on the same VHF Data Link (VDL) of the AIS. There are 64 FI's available, all of which must be allocated to one of the following groups of application fields:

- General Usage (Gen)
- Vessel Traffic Services (VTS)
- Aids to Navigation (AtoN)
- Search and Rescue (SAR)

While most FIs are currently designated as "reserved for future use", some have been allocated to certain internationally recognised applications, being termed International Function Identifiers (IFIs). The applications are activated through the use of International Function Messages (IFMs) within Binary Messages using 6-bit ASCII text.

8.4.2 VTS TARGETS

A proven application of AIS, termed "Radar Target Broadcasting" or "VTS Foot printing", is the process of converting radar target information from a VTS centre and retransmitting it to AIS fitted vessels in the area as unvalidated synthetic AIS targets. This allows all AIS fitted vessels in the vicinity to view all VTS tracked radar targets and AIS targets as well as those being tracked on their own radar(s).

IFM 16 is used to transmit VTS targets, to a maximum of 7 in any one message. Because of the impact on VDL channel loading, IFM 16 should only be transmitted to provide the necessary level of safety. Each VTS target message is structured as in Table 18.

Parameter	Description
Type of Target Identifier	Identifier Type: 0 = The target identifier should be the MMSI number. 1 = The target identifier should be the IMO number. 2 = The target identifier should be the call sign. 3 = Other (default).
Target ID	Target Identifier. The Target ID should depend on Type of Target Identifier above. When call sign is used, it should be inserted using 6-bit ASCII. If Target Identifier is unknown, this field should be set to zero. When MMSI or IMO number is used, the least significant bit should equal bit zero of the Target ID.
Latitude	Latitude in 1/1000 of a minute.
Longitude	Longitude in 1/1000 of a minute.
COG	Course over ground in degrees (0-359); 360 = not available = default.
Time Stamp	UTC second when the report was generated (0-59, or 60 if time stamp is not available, which should also be the default value)
SOG	Speed over ground in knots; 0-254; 255 = not available = default.

Table 18: VTS targets - Message Structure

Note: A VTS target should only be used when the position of the target is known. Note that the target identity and/or course and/or time stamp and/or speed over ground may be unknown.

8.4.3 INTERNATIONAL FUNCTION MESSAGE 17 (IFM 17) - SHIP WAYPOINTS/ ROUTE PLAN

A ship uses IFM 17 to report its waypoints and/or its route plan. If the reporting ship uses this IFM 17 within an Addressed Binary Message, then the waypoints and / or the route plan will only be available to the addressed station, that is a Base Station (VTS centre) or another ship. If the reporting ship uses IFM 17 within a Broadcast Binary Message, then the information will be available to all other AIS stations in its vicinity.

When transmitting a Route Plan the transmitting station can include up to 14 Next Waypoints (NWP), if available, and/or a route specified by a textual description. The NWPs should be transmitted in the sequence of the intended passage.

Parameter	Description
NWP	Number of Next Waypoints (NWP) available (1 -14); 0 = no Next Waypoint available = default; 15 = not used
WP **i**.Lon	Longitude of Next Waypoint **i** in 1/10 000 min (±180 degrees, East =positive, West = negative). Field required if and as often as 1 ≤ **i** ≤ NWP, **i** = 1, 2, 3,…,14; Field not required if NWP = 0.
WP **i**.Lat	Latitude of Next Waypoint **i** in 1/10 000 min (± 90 degrees, North = positive, South = negative). Field required if and as often as 1 ≤ **i** ≤ NWP, **i** = 1, 2, 3, …..,14; Field not required if NWP = 0.
Route specified by Textual Description	Description of the route information in textual form, e. g. "West Channel"; maximum 20 characters using 6-bit ASCII; "@@@@@@@@@@@@@@@@@@@@" = not available (field must not be omitted).

Table 19: Ship Waypoints/Route Plan - Message Structure

The number of slots used for this message depends on the number of Next Waypoints transmitted as follows:

Number of Next Waypoints transmitted	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Number of slots used for this message	2	2	2	3	3	3	3	4	4	4	4	5	5	5	5

8.4.4 IFM 18 Advice of VTS Waypoints/Route Plan

IFM 18 is used by a VTS centre to advise ships of the waypoints and/or route plans used in that particular VTS area. If the VTS uses this IFM 18 message within an Addressed Binary Message, then the information will only be available to the addressed recipient, that is, one ship. If the VTS uses IFM 18 within a Broadcast

Binary Message, then the information will be available to all other ships in VHF reception range of the transmitting VTS centre.

When transmitting this information the VTS centre can include up to 12 Advised Waypoints (AWP), if available, and/or a route specified by a textual description. If waypoints are transmitted, then a recommended turning radius can be included for each waypoint.

Parameter	**Description**
AWP	Number of Advised Waypoints (1 - 12); 0 = no waypoint = default; 13 - 15 = not used
WP **i**.Lon	Longitude of Advised Waypoint **i** in 1/10 000 min (±180 degrees, East = positive, West = negative). Field required if 1 ≤ **i** ≤ AWP, **i** = 1, 2, 3, ….., 12; Field not required if AWP = 0.
WP **i**.Lat	Latitude of Advised Waypoint **i** in 1/10 000 min (± 90 degrees, North = positive, South = negative). Field required if 1 ≤ **i** ≤ AWP, **i** = 1, 2, 3, …, 12; Field not required if AWP = 0.
Advised Turning Radius **i**	Advised Turning Radius at Advised Waypoint **i** in metres; 0 = not available = default; 1 - 4 095 metres. Field required if and as often as 1 ≤ **i** ≤ AWP, **i** = 1, 2, 3, ….., 12; Field not required if AWP = 0.
Advised Route specified by Textual Description	Description of the advised route in textual form, e. g. "West Channel"; maximum 20 characters using 6-bit ASCII; "@@@@@@@@@@@@@@@@@@@@" = not available (field must not be omitted).

Table 20: Advice of VTS Waypoints/Route Plan - Message Structure

The number of slots used for this message depends on the number of Next Waypoints transmitted as follows:

Number of Advised Waypoints transmitted	0	1	2	3	4	5	6	7	8	9	10	11	12
Number of slots used for this message	2	2	2	3	3	3	4	4	4	4	5	5	5

8.4.5 IFM 19 - EXTENDED SHIP STATIC AND VOYAGE RELATED DATA

IFM 19 is used by a ship to report height above keel (air draught), as a component of voyage related data. This additional information would normally be supplied at the Master's discretion or on request from a competent authority.

Parameter	Description
Height over keel	in 1/10 m; 2047 = height over keel 204.7 m or greater, 0 = not available = default
This IFM uses one slot	

Table 21: Height over Keel

8.4.6 IFM 40 - Number of Persons Onboard

IFM 40 is used by a ship to report the number of persons on board, normally provided at the Master's discretion or on request from a competent authority.

Parameter	Description
Number of Persons	Current number of persons onboard, including crew members: 0- 8191; default = 0 = not available; 8191 = 8191 or more
This IFM uses one slot	

Table 22: Number of Persons Onboard

9 USE OF AIS INFORMATION

9.1 USE OF AIS INFORMATION IN COLLISION AVOIDANCE

A study of the German Marine Board of Inquiry into the causes of collisions at sea in the period 1983-1992 indicated that most of the so called "radar assisted collisions" (see Figure 6) occurred in restricted visibility when radar provided insufficient, incomplete or ambiguous data[3] The study concluded that many of these collisions could have been avoided if the navigators involved had been able to access timely, and dynamic information (position, heading, speed and rate of turn etc) on the other vessel involved. AIS in the ship-ship application can now provide such dynamic information accurately and at high update rates, when target information is available on the ships involved.

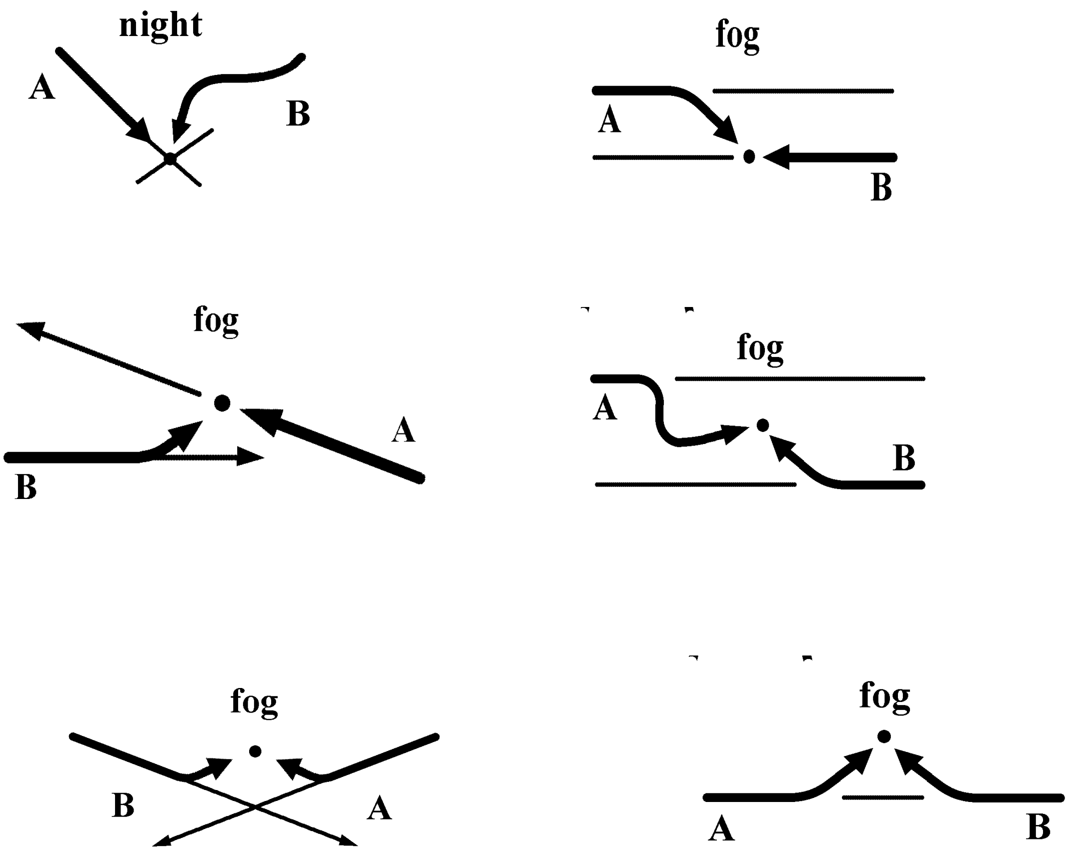


Figure 6: Some Examples of Collision Scenarios at Sea

9.1.1 Risk of Collision

COLREG Rule 7 - Risk of Collision - states that *"Every vessel shall use all available means appropriate to the prevailing circumstances and conditions to determine if risk of collision exists. If there is any doubt such risk shall be deemed to exist."*

[3] IMO Paper NAV 43/7/16, Automatic Identification Systems (AIS), Note by Germany dated 16 May 1997.

The COLREGs oblige ships to apply all available means to detect the danger of collision and to take preventive measures. One of these means, especially during reduced visibility, is ship-borne radar; another aid now available is AIS.

The following sections contrast the performance of radar with AIS and demonstrate how AIS could mitigate many of the limitations of radar.

9.1.2 Limitation of radar performance

When considering radar performance for collision avoidance, a distinction needs to be made between raw radar targets and tracked radar targets. The reliability of both, as discussed in the following section, involves issues of accuracy and the degree of delay of presentation.

9.1.3 Raw Radar Targets

The shape of the raw radar echo of targets does not normally give a true representation of the real dimensions of a target. From the azimuth perspective, and depending on the target aspect and distance, the echo may be smaller at very long range or considerably larger at medium ranges. This is a function of the antenna beam width. Thus, a ship at long range, approaching the observing radar may appear to be a vessel orientated at right angles to its true movement.

This distortion of target information is especially true in the case of a large vessel such as a tanker with a high superstructure aft, where the visible radar echo is probably reflection from the after structure and not the centre of the ship.

9.1.4 Radar information

There are more aspects, such as the resolution of the monitor used and raw radar processing, which presents targets that are neither equivalent to the real target's dimension nor symmetrical to it. Thus, in most cases, one cannot reliably assess, from radar observation alone, the heading of a vessel, which may also differ from the course over ground.

Further, when altering course, a vessel's hull experiences two actions. Altering the position of the rudder, e.g. to starboard, causes the vessel to turn around its centre of rotation, which may be located a third of the ship's length from the stem. This centre itself still moves straight on over ground, while the part ahead of the centre moves to starboard of the centre while the part aft of it turns to port of it. As a consequence the whole ship begins to change course over ground.

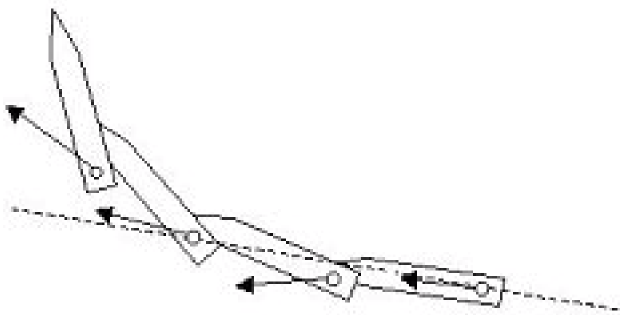


Figure 7:
At the commencement of a course alteration the larger (radar reflecting) part of a vessel moves in a direction opposite to the actual direction of turn and may give a

stronger radar echo because of the higher superstructure of the ship. It may, therefore, be difficult to instantaneously decide, from its raw radar presentation alone, the actual direction of a manoeuvre by another vessel. Indeed, the instantaneous assessment may be misleading and dangerous if acted upon.

9.1.5 Tracked Radar Targets

The radar track of a vessel is usually “smoothed” by a filtering process to remove the deviations caused by the alterations of reflectivity, pitch, roll and yaw. This process reduces true positional accuracy and creates a display delay. In the case of a course alteration, it may take 5-10 antenna rotations to determine a target vessel’s movement. If the radar plot position of a target vessel is aft of its true centre of rotation, this may also produce a false indication of the target ship’s direction of turn.

9.1.6 ARPA/ATA

The limitations of automatic radar plotting aids (ARPA) and automatic tracking aids (ATA) are apparent from the IMO Performance standards. It should be noted that the inaccuracies mentioned therein refer to a movement on an unmodified course for one to three minutes. For course alterations there is no specification at all.

9.1.7 AIS Performance

AIS broadcasts the identity, position, heading, course over ground (COG), speed over ground (SOG) and certain other relevant ship data at an update rate dependent upon the ship’s speed or rate of turn during course alterations. Its performance surpasses ship-borne radar in three aspects:

- AIS aims to achieve a positional accuracy of better than 10 m when associated with DGNSS corrections. This compares favourably with radar whose accuracy is a function of frequency, pulse repetition rate and beam width and which will often achieve a positional accuracy of 30-50 m
- Due to the higher positional accuracy and less need for plot filtering, the position and changes of course over ground can be presented with less delay than that by radar.
- The AIS provides supplementary information about other vessels that is not readily available from radar, such as identity, heading, COG, SOG, rate of turn and navigational status.

On the basis of this more accurate and complete information, the passing distance between vessels can be determined with higher accuracy and reliability. From the navigational status information available, any manoeuvring restrictions on a vessel become immediately evident and can be taken into account.

As a result, it can be seen that AIS provides more complete information than ship-borne radar. When used in conjunction with radar, it enhances the available information. AIS can also assist in the identification of targets by name or call sign and by ship type & navigational status, thus reducing the requirement for verbal information exchange.

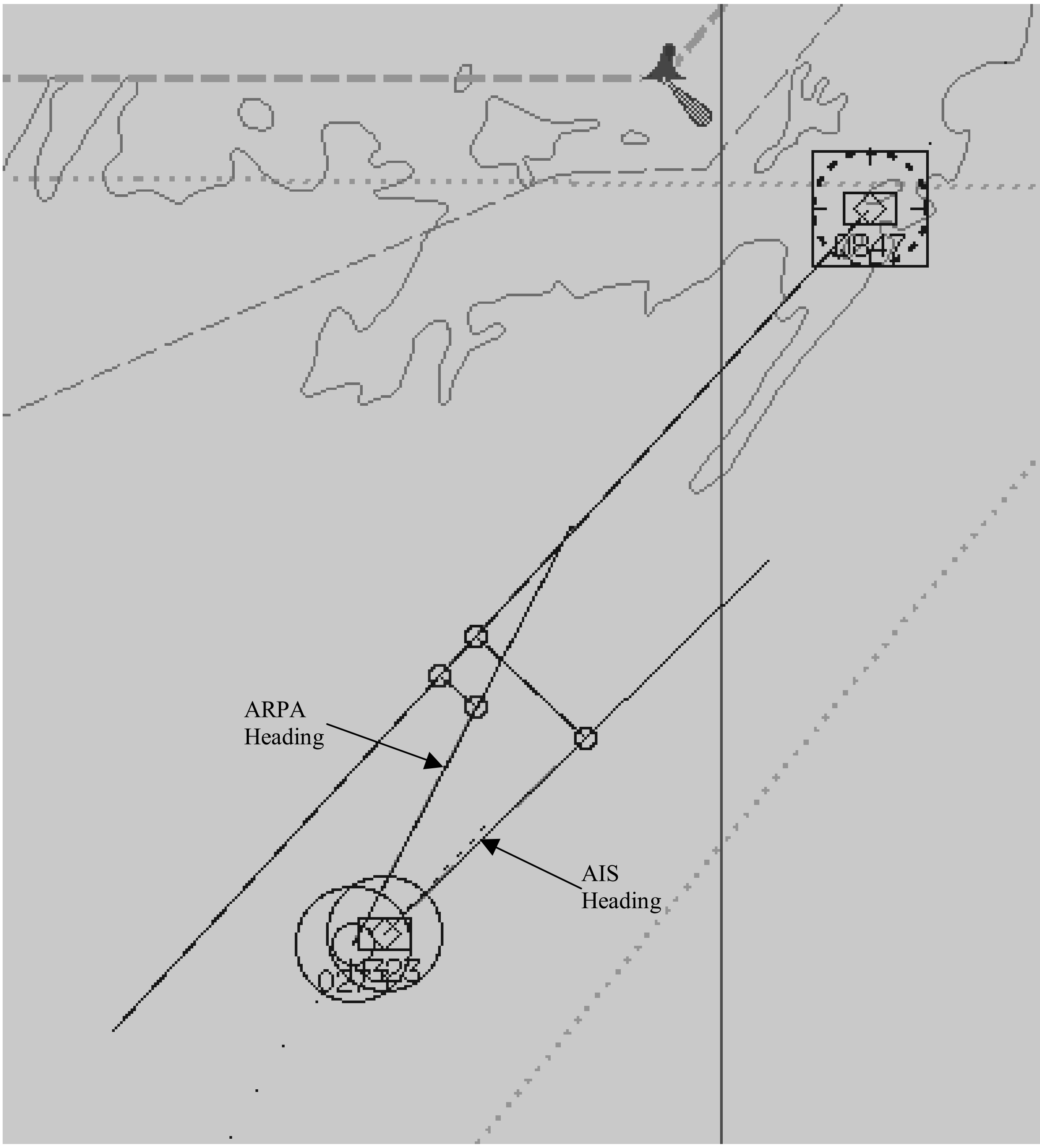


Figure 8: Comparison of Radar (ARPA) and AIS

The attached screen shot clearly shows the difference between the radar-ARPA and the AIS information for collision avoidance. While the ARPA shows a crossing situation the AIS clearly indicates the red to red situation

9.2 OPERATIONAL REQUIREMENTS

In addition to the relevant performance standards, AIS information may be presented and displayed according to the following interim guidelines.

9.2.1 Presentation of information

If AIS information is made available for a graphical display, at least the following information should be displayed: (see resolution MSC 74(69), Annex 3 (AIS), paragraph 6 and IMO S/N Circular 217 of July 2001):

- position
- course over ground
- speed over ground
- heading
- rate of turn, or direction of turn, as available

If information provided by AIS is graphically presented, the symbols described in Table 1 should be applied. In the case of a radar display, radar signals should not be masked, obscured or degraded.

Whenever the graphical display of AIS targets is enabled, the graphical properties of other target vectors should be equivalent to those of the AIS target symbols, otherwise the type of vector presentation, (radar plotting symbols or AIS symbols), may be selectable by the operator. The active display mode should be indicated.

The presentation of AIS target symbols, except for sleeping or lost targets, should have priority over other target presentations within the display area, including targets from EPA, ATA or ARPA. If such a target is marked for data display, the existence of the other source of target data may be indicated, and the related data may be available for display upon operator command.

The mariner should be able to select additional parts of the information from AIS targets, which should then be presented in the data area of the display, including the ship's identification (at least the MMSI). If the received AIS information is not complete, this should be indicated.

A common reference should be used for the superimposition of AIS symbols with other information on the same display, and for the calculation of target properties (e.g. TCPA, CPA).

If AIS information is graphically displayed on radar, the equipment should be capable of appropriately stabilising the radar image and the AIS information.

Target data derived from radar and AIS should be clearly distinguishable as such.

The operator may choose to display all or any AIS targets for graphical presentation. The mode of presentation should be indicated.

If the display of AIS symbols is enabled, removing a dangerous target should only be possible temporarily as long as the operator activates the corresponding control.

The AIS symbol of an activated target may be replaced by a scaled ship symbol on a large scale/small range display.

If the COG/SOG vector is shown, its reference point should be either the actual or the virtual position of the antenna.

Means should be provided to select a target or own ship for the display of its AIS data on request. If more than one target is selected, the relevant symbols and the corresponding data should be clearly identified. The source of the data, e.g., AIS, radar, should be clearly indicated.

9.2.2 Processing of information

If zones or limits for automatic target acquisition are set, these should be the same for automatically activating and presenting any targets regardless of their source.

The vector time set should be adjustable and valid for presentation of any target regardless of its source.

If radar-plotting aids are used for the display of AIS information, these should be capable of calculating and displaying collision parameters equivalent to the available radar plotting functions.

If the calculated CPA and TCPA values of an AIS target are less than the set limits,

- a dangerous target symbol should be displayed and
- an alarm should be given.

The pre-set CPA/TCPA limits applied to target data derived from different sensors should be identical.

If the signal of a dangerous AIS target is not received for a set time:

- a lost target symbol should appear at the latest position and an alarm be given;
- the lost target symbol should disappear after the alarm has been acknowledged; and
- means to recover the data for a number of last acknowledged lost targets may be provided.

Preferably this function may also be applied to any AIS target within a certain distance.

An automatic display selection function may be provided to avoid the presentation of two target symbols for the same physical target. If target data from AIS and from radar plotting functions are available, then the activated AIS target symbol should be presented, if the automatic selection criteria are fulfilled, otherwise the respective symbols should be displayed separately. The operator should have the option to make reasonable changes to the default parameters of automatic selection criteria.

Means should be provided to display and acknowledge alarm messages from own AIS. Indication should be given if own AIS is out of service or switched off.

9.3 HUMAN INTERFACE

As far as practical, the user interface for operating, displaying and indicating AIS functions should be equivalent to the other relevant functions of the navigational aid.

Note: AIS uses WGS84 datum. Users should be aware that alternative datums used in electronic aids or referenced on a paper chart may induce positional errors.

9.4 USE OF AIS ASHORE

[*The potential to increase the role of AIS in divers and innovative applications is vat, limited perhaps only by data-link restrictions. Competent Authorities can utilize AIS for appropriate levels of maritime traffic oversight in non-VTS ports, on a pulsed or continuous basis. AIS can be a major contributor to Maritime Domain Awareness (MDA) by providing vessel accountability. AIS can enhance productivity via fleet management and shore side monitoring of operation/engineering functions, if the data link permits this. The way ahead is not yet charted but, as such use is contemplated, the basic objective of ship-ship data exchange reliability must remain a prime concern*.]

9.5 LIMITATIONS ASSOCIATED WITH THE USE OF AIS

Although AIS has the potential to greatly enhance VTS operations, the system does have several limitations or potential drawbacks. For example:

- VTS operators may become overly dependent on AIS and, therefore, may treat the system as a sole or primary means for vessel identification; as a result, they may fail to identify contacts, because all vessels may not be equipped with AIS transponders;
- AIS is subject to the same vagaries and vulnerabilities of VHF-FM;
- When a AIS unit reaches its saturation point (maximum number of transmission receipts), TDMA prevents overload of the AIS unit by culling transmissions, accepting those closest to the unit and eliminating those furthest away, a feature particularly useful to ships, which must pay particular attention to those vessels in closer proximity; however, this feature could prove detrimental to VTS operations that must service a large area and must give equal if not more attention to areas distant from a VTS transponder site(s); and
- AIS is not intended to be a general communications means; therefore, to match general communications requirements, mariners and VTS operators should use the appropriate and emerging new general communications technologies.
- Whilst AIS tracks will avoid the great majority of radar shadow effects, the very close proximity of buildings and bridges, sometimes known as the “urban canyon” effect, can cause difficulties for AIS transponders in heavily built-up areas. This is a consequence of inhibiting either the reception of the differential GNSS signal by the AIS transponder, or the transmission of the subsequent AIS message.

9.6 AVAILABILITY OF NATIONAL/REGIONAL/LOCAL DGNSS CORRECTIONS

In order to monitor vessel navigation with the 10-metre accuracy potentially possible, a reliable DGNSS correction signals will need to be made available to all vessels throughout the VTS area. Such services are provided nationally or regionally in some areas. Where such a service does not exist, a VTS authority may consider providing these corrections itself. It is technically possible to transmit the relevant corrections using the AIS itself.

10 USE OF AIS IN PILOTAGE

10.1 OVERVIEW

In pilotage areas like ports, harbours, rivers and archipelagos, the effectiveness of AIS with high update rates is evident; the AIS will be invaluable for navigation, reporting, and communication purposes.

The limitations of the ARPA radar to track vessels due to target swapping from a vessel to land, beacons, bridges and other vessels makes the ARPA capabilities very limited in narrow and congested waters. AIS used in conjunction with ARPA radar enhances its function.

Safety will be improved by using AIS in pilotage waters and the broadcast AIS will achieve this by:

- identifying vessels by name, heading, course over ground (COG), speed over ground (SOG), size, draught and type of vessel.
- detecting and identifying vessels especially in restricted visibility e.g. behind a bend in a channel or behind an island in an archipelago.
- predicting the exact position of a meeting with another vessel(s) in a river, port or in the archipelago. Thus allowing for the correct manoeuvre to be made for collision avoidance purposes.
- identifying which port or harbour a vessel is bound for
- detecting a change in a vessel's heading almost in real time

10.2 POSSIBLE FUTURE USE OF AIS IN PILOTED WATERS

In addition to the use of AIS standard messages there is a need to use special messages created for use in a specific pilotage area because of differing local conditions.

Examples of information that could be exchanged via AIS in piloted waters:

- actual wind direction and speed
- actual current direction and speed
- actual water level
- actual water and air temperature
- floating aids to navigation on station or off station
- fixed aids to navigation as reference targets for radar
- aids to navigation status/identity
- validated synthetic aids to navigation
- local management messages
- locks open/closed
- bridges open/closed
- tension power on tug lines
- orders to tug boats
- traffic information from the VTS

AIS also provides the facility for a VTS centre to broadcast VTS targets to vessels. A VTS target is any target that can be displayed at the VTS centre including radar

targets, DF targets and ARPA targets. What this means for the pilot is that he will be able so see all the vessels the VTS operator sees, even if those vessels do not have an AIS onboard.
The creation and use of these special messages to fulfil local requirements will assist both the pilot and the VTS in their respective tasks. For example, the AIS can provide a bird's eye view of a docking operation with tugboats connected or pushing including information such as bollard pull, directions of pull and even issuing the commands to the tugboats through the Pilot Pack.

Special local applications in e.g. rivers, canals, harbours and archipelagos will most certainly be one of the tools for a pilot or a master with pilot exemption to make their job more efficient. The AIS is able to handle both internationally agreed messages and locally designed messages. This makes the AIS one of the major tools for the pilot in the future.

10.3 PORTABLE PILOT PACK

There are two types of portable carry onboard pilot AIS equipment. The first type is a pilot workstation combined with a portable AIS. The second type is a pilot workstation, which connects to the pilot port connector of an onboard AIS.

- A pilot workstation combined with portable AIS is used primarily to provide marine pilots with the capability to carry onboard an AIS station when piloting vessels not fitted with AIS. Such a Pilot Pack contains GNSS/DGNSS, AIS, (optional) heading sensor, and a workstation. The heading sensor is essential if the vessel is using the Pilot Pack for navigating in waters where there are frequent course alterations. Without the heading sensor the AIS will not provide this vital bit of information to other vessels in the vicinity.

- Over time, most of the vessels that are piloted will be fitted with AIS, according to the SOLAS Convention. The onboard AIS has a pilot/auxiliary input/output port which provides the facility to forward the own vessel's GNSS/DGNSS information, heading, and (optional) rate of turn continuously, independently of (i.e. faster than) the standard AIS reporting rate. The pilot will receive all other AIS information at the standard rate. This allows pilots to plug in their own pilot portable workstation to the onboard AIS in order to receive more frequent own ship navigation information. In addition the pilot port provides the pilot the facility to forward information to other vessels in the vicinity or to the local VTS.

- When installing the AIS, there should be connectivity to the AIS pilot port from those locations at which the pilot would use his workstation (see Chapter 11). In addition, power supply should be available at the same location(s).

11 INSTALLATION OF AIS ON BOARD

Guidelines are needed to assist installers and surveyors in the safe and effective installation of onboard AIS. Attached at Annex 1 are draft installation guidelines, being presented to IMO NAV 48 (July 2002) for approval. These guidelines take into account the technical characteristics of a ship borne AIS using time division multiple access in the VHF maritime mobile band (ITU-R M.1371-1) and the Class A ship borne equipment of the AIS (IEC 61993-2), neither of which address installation aspects.

ANNEX 1 IMO GUIDELINES FOR INSTALLATION OF SHIPBORNE AUTOMATIC IDENTIFICATION SYSTEM (AIS)

The AIS Class A is defined by IMO and has been made a carriage requirement by the latest revision of SOLAS Chapter V. AIS provides information that may be used for the navigation of the ship. It is therefore essential that the information provided by AIS be reliable.

The AIS itself has been standardised by the International Telecommunications Union (ITU) and the International Electrotechnical Commission (IEC) and is subject to type approval. In order to fulfil the reliability requirements of information exchange, care should be taken to ensure the AIS is correctly installed.

This document is a guideline for manufacturers, installers, yards, suppliers and ship surveyors. It does not replace documentation supplied by the manufacturer.

The guidelines take into account the following conventions, regulations, instructions and guidelines:

- IMO Resolution MSC 90 (73) Annex 7, Adoption of amendments to the international convention for the safety of life at sea, as amended.
- IMO Resolution MSC 74 (69) Annex 3, Recommendation on performance standards for AIS.
- ITU Radio Regulations (RR).
- IEC 60092 (series), Electrical Installations on Ships.
- IEC 60533 Electrical and Electronic Installations in Ships – Electromagnetic Compatibility.

1 SURVEY

Surveys on Convention ships should be carried out in accordance with the rules laid down in IMO Res. A 746(18) "Survey Guidelines under the harmonised system of survey and certification" and "Protocol of 1988 relating to the International Convention for the Safety of Life at Sea, 1974, as amended."

2 DOCUMENTATION

For the AIS installation the following drawings shall be submitted:

- Antenna layout
- AIS arrangement drawing
- Block diagram (interconnection diagram)

An initial installation configuration report should be produced during installation and kept on board.

3 AIS INSTALLATION

3.1 INTERFERENCE TO THE SHIP'S VHF RADIOTELEPHONE

The AIS ship borne equipment, like any other ship borne transceiver operating in the VHF maritime band, may cause interference to a ship's VHF radiotelephone. Because AIS is a digital system, this interference may occur as a periodic (e.g. every 20 second) soft clicking sound on a ship's radiotelephone. This affect may become more noticeable when the VHF radiotelephone antenna is located near the AIS VHF antenna and when the radiotelephone is operating on channels near the AIS operating channels (e.g. channels 27, 28 and 86).

Attention should be paid to the location and installation of different antennas in order to obtain the best possible efficiency. Special attention should be paid to the installation of mandatory antennas like the AIS antennas.

3.2 VHF ANTENNA INSTALLATION

3.2.1 Location

Location of the mandatory AIS VHF-antenna should be carefully considered. Digital communication is more sensitive than analogue/voice communication to interference created by reflections in obstructions like masts and booms. It may be necessary to relocate the VHF radiotelephone antenna to minimize interference effects.

To minimise interference effects, the following guidelines apply:

- The AIS VHF antenna should have omni directional vertical polarisation.
- The AIS VHF antenna should be placed in an elevated position that is as free as possible with a minimum of 2 metres in horizontal direction from constructions made of conductive materials. The antenna should not be installed close to any large vertical obstruction. The objective for the AIS VHF antenna is to see the horizon freely through 360 degrees.
- The AIS VHF antenna should be installed safely away from interfering high-power energy sources like radar and other transmitting radio antennas, preferably at least 3 meters away from and out of the transmitting beam.
- Ideally, there should not be more than one antenna on the same level. The AIS VHF antenna should be mounted directly above or below the ship's primary VHF radiotelephone antenna, with no horizontal separation and with a minimum of 2 metres vertical separation. If it is located on the same level as other antennas, the distance apart should be at least 10 metres.

3.2.2 Cabling

The cable should be kept as short as possible to minimise attenuation of the signal. Double-screened coaxial cables equal or better than RG214 are recommended.

All outdoor installed connectors on the coaxial cables should be waterproof by design to protect against water penetration into the antenna cable.

Coaxial cables should be installed in separate signal cable channels/tubes and at least 10 cm away from power supply cables. Crossing of cables should be done at right angles (90°). Coaxial cables should not be exposed to sharp bends, which may lead to a change in the characteristic impedance of the cable. The minimum bend radius should be 5 times the cable's outside diameter.

3.2.3 Grounding

Coaxial down-leads must be used for all antennas, and the coaxial screen should be connected to ground at one end.

3.3 GNSS ANTENNA INSTALLATION

A Class A AIS shall be connected to a GNSS antenna.

3.3.1 Location

The GNSS antenna must be installed where it has a clear view of the sky. The objective is to see the horizon freely through 360 degrees with a vertical observation of 5 to 90 degrees above the horizon. Small diameter obstructions, such as masts and booms, do not seriously degrade signal reception, but such objects should not eclipse more than a few degrees of any given bearing.

Locate the antenna at least three meters away from and out of the transmitting beam of high-power transmitters (S-Band Radar and/or INMARSAT systems). This includes the ship’s own AIS VHF antenna if it is designed and installed separately.

If a DGNSS system is included or connected to the AIS system, the installation of the antenna shall be in accordance with IEC 61108-4, Ed 1, annex D.

3.3.2 Cabling

To achieve optimum performance, the gain of the antenna pre-amplifier should match the cable attenuation. The resulting installation gain (pre-amplifier gain - cable attenuation) should be within 0 to 10 dB.

The coaxial cable between the antenna and the AIS ship borne station connector should be routed directly in order to reduce electromagnetic interference effects. The cable should not be installed close to high-power lines, such as radar or radio-transmitter lines or the AIS VHF antenna cable. A separation of one meter or more is recommended to avoid degradation due to RF-coupling. Crossing of antenna cables should be done at 90 degrees to minimise magnetic field coupling.

All outdoor installed connectors on the coaxial cables should be waterproofed by design to protect against water penetration into the antenna cable.

3.4 POWER SOURCE

The AIS shall be connected to an emergency power source.[4]

3.5 SYNCHRONIZATION

After installation, the AIS should be synchronised properly on UTC and that position information, if provided, should be correct and valid.

4 BRIDGE ARRANGEMENT

4.1 MINIMUM KEYBOARD AND DISPLAY

The functionality of the Minimum Keyboard and Display (MKD) should be available to the mariner at the position from which the ship is normally operated. This can be by means of the AIS’ internal MKD (integrated or remote) or through the equivalent functionality on a separate display system.

[4] A further requirement to connect AIS to the reserve power source of the GMDSS is under review by IMO.

4.2 PILOT PLUG

A pilot input/output port is part of an AIS Class A station. A plug connected to this port should be installed on the bridge near the pilot's operating position so that a pilot can connect a Portable Pilot Unit (PPU).

The pilot plug should be configured as follows:

- AMP/Receptacle (Square Flanged (-1) or Free-Hanging (-2)), Shell size 11, 9-pin, Std. Sex 206486-1/2 or equivalent with the following terminations:
    - TX A is connected to Pin 1
    - TX B is connected to Pin 4
    - RX A is connected to Pin 5
    - RX B is connected to Pin 6
    - Shield is connected to Pin 9

4.3 DISPLAY SYSTEM

If there is navigational equipment capable of processing and displaying AIS information such as ECDIS, radar or an integrated system available onboard the ship, the AIS Class A mobile system may be connected to that system via the AIS Presentation Interface (PI). The PI (input/output) should meet the requirements of IEC 61162-2. The display system can also include the functionality of an MKD (see paragraph on MKD above).

4.4 INSTALLATION OF THE BIIT (BUILT-IN INTEGRITY TEST) FUNCTION

The AIS requires that an alarm output (relay) be connected to an audible alarm device or the ship's alarm system, if available.

Alternatively, the BIIT alarm system may use the alarm messages' output on the PI, provided its alarm system is AIS compatible.

5 DYNAMIC DATA INPUT

5.1 EXTERNAL SENSORS

The AIS has interfaces (configurable as IEC 61162-1 or 61162-2) for position, heading and rate of turn (ROT) sensors. In general, sensors installed in compliance with other carriage requirements of SOLAS Chapter V should be connected to the AIS. [5]. The sensor information transmitted by AIS should be the same information being used for navigation of the ship. The interfaces should be configured as given in annex 3. Interfacing problems might occur if the existing sensors found on board do not have serial (IEC 61162) outputs.

5.2 POSITION, COG AND SOG

GNSS position sensors normally have IEC 61162 outputs for position, COG and SOG suitable for directly interfacing the AIS. However, it is important to note that:

- The Geodetic Datum of the position data transmitted by the sensor is WGS84 and that an IEC 61162 DTM sentence is configured.

[5] Installation of the AIS does NOT establish a need to install additional sensors above carriage requirements.

- AIS is able to process two reference points for its antenna position, one for external and one for an internal sensor. If more than one external reference point is used, the appropriate information needs to be input to the AIS to adjust reference point information.

5.3 HEADING

A compass providing heading information is a mandatory sensor input to the AIS. A converter unit (e.g. stepper to NMEA) will be needed to connect AIS if the ship's compass does not provide an IEC 61162 output. Some ships of less than 500 gross tonnage may not carry a compass providing heading information.

5.4 RATE OF TURN

All ships may not carry a Rate-Of-Turn (ROT) Indicator according to resolution A.526(13). However, if a rate-of-turn indicator is available and it includes an IEC 61162 interface, it should be connected to the AIS.

If ROT information is not available from a ROT indicator, the direction of turn may (optionally) be derived from heading information through:

- the compass itself,
- an external converter unit (see paragraph on Heading above),
- the AIS itself (see Annex A).

5.5 NAVIGATIONAL STATUS

A simple means should be provided for the operator to input the ship's navigational status (e.g. underway using engine, at anchor, not under command, restricted in ability to maneuver, etc) information into the AIS. The AIS may be connected to the ship's navigational status lights.

6 STATIC INFORMATION

The AIS standards require that certain static, voyage-related, and dynamic information be entered manually, normally by means of the MKD, or by means of IEC 61162 sentences "SSD" and "VSD" via the presentation interface if such provisions exist.

6.1 ENTERED AT INITIAL INSTALLATION OF AIS

Information that should be entered at the initial installation of the AIS includes:

- Maritime Mobile Service Identity (MMSI) number
- IMO vessel number
- Radio call sign
- Name of ship
- Type of ship
- Dimension/reference for position of the electronic position fixing device (EPFD) antenna (see paragraph on Reference point of position below).

Access to **MMSI, IMO number** and other AIS controls (like power and channel settings) will be controlled, e.g. by password.

The **Call Sign**, **Name of Ship** and **Type of Ship** should be input to the AIS, either manually using the MKD or by means of IEC 61162 sentences "SSD" and "VSD" via the PI. Type of Ship information should be in accordance with the table given in Annex B (Table 18 from Rec. ITU-R M.1371-1).

For example, a cargo ship not carrying dangerous goods, harmful substances, or marine pollutants; would use identifier "70". Pleasure craft would use identifier "37". Note that those ships whose type identifier begins with a "3" should use the fourth column of the table.

Depending on the vessel, cargo and/or the navigational conditions, this information may be voyage related and would therefore need to be changed before beginning or at some time during the voyage. This is defined by the "second digit" in the fourth column of the table.

6.2 REFERENCE POINT OF POSITION

The AIS stores one "external reference point" for the external GNSS antenna position and one "internal reference point" if an internal GNSS is to be used as fallback for position reporting. The locations of these reference points have to be set during installation using values A, B, C, D; as described in the paragraph on Ship's dimensions below.

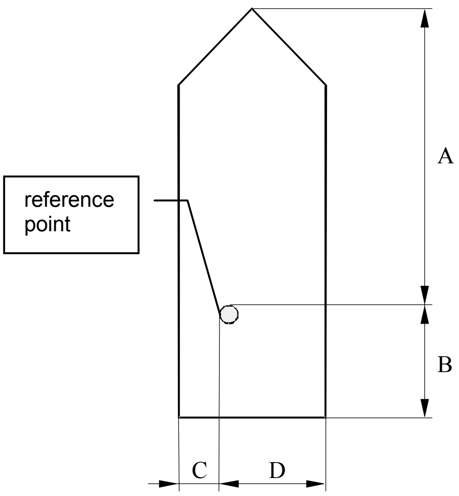
The external reference point may also be a calculated common reference position.

Additionally, the content of the Ship Static Data ("SSD") sentence on the PI, including the "reference point for position" is being processed by the AIS, and the AIS' memory for the "external reference point" is set in accordance with the content of this 'SSD' (e.g. used by an INS).

6.3 SHIP'S DIMENSIONS

Ship's dimensions should be entered using the overall length and width of the ship indicated by the values A, B, C, and D in the following figure.

Ship's dimensions (A+B and C+D) should be identical when entering internal and external reference points.



	Distance (m)
A	*0 – 511; 511 = 511 m or greater*
B	*0 – 511; 511 = 511 m or greater*
C	*0 - 63; 63 = 63 m or greater*
D	*0 - 63; 63 = 63 m or greater*

The dimension A should be in the direction of the transmitted heading information (bow)

Reference point of reported position not available, but dimensions of ship are available: A = C = 0 and B ≠ 0 and D ≠ 0.
Neither reference point of reported position nor dimensions of ship available: A = B = C = D = 0 (=default)
For use in the message table, A = most significant field, D = least significant field

Figure 9: Ship's Dimensions

In the rare case of an EPFD antenna installed in the portside corner of a rectangular bow, the values A and C would be zero. Should this be the case, one of these values should be set to 1 in order to avoid misinterpretation as “not available“ because A=C=0 is used for that purpose.

7 LONG-RANGE FUNCTION

The AIS' long-range function needs a compatible long-range communication system (e.g. INMARSAT C or MF/HF radio as part of GMDSS).

If this is available, a connection between that communication system and the Class A mobile unit can be made. This connection is needed to activate the LR function of AIS. Its input/output port should meet the requirement of IEC 61162-2.

8 ANNEX A - RATE OF TURN

The AIS provides the Rate of Turn (ROT) information to other ships in order to early detect ships manoeuvres. There are two possible parameters indicating turning of a ship derived from two different sensors (see Figure 10: ROT sensor input):

- the heading from a GYRO or THD and
- the rotation rate itself from a Rate of Turn-indicator.

If a Rate of Turn Indicator according to resolution A.526(13) is connected the AIS should use this information to broadcast both direction and value of turn on the VDL.

If valid “ROT” or “HDG” data is available from other external sources (Gyro, INS,...), the AIS should use this information to broadcast the direction of turn on the VDL, if greater than 5^0 in 30s (might also be implemented as 2.5° in 15s by configuration); the AIS may also derive ROT information from HDG internally for that purpose.

If no ROT information is available, the AIS should transmit default values indicating “not available”. ROT data should not be derived from COG information.

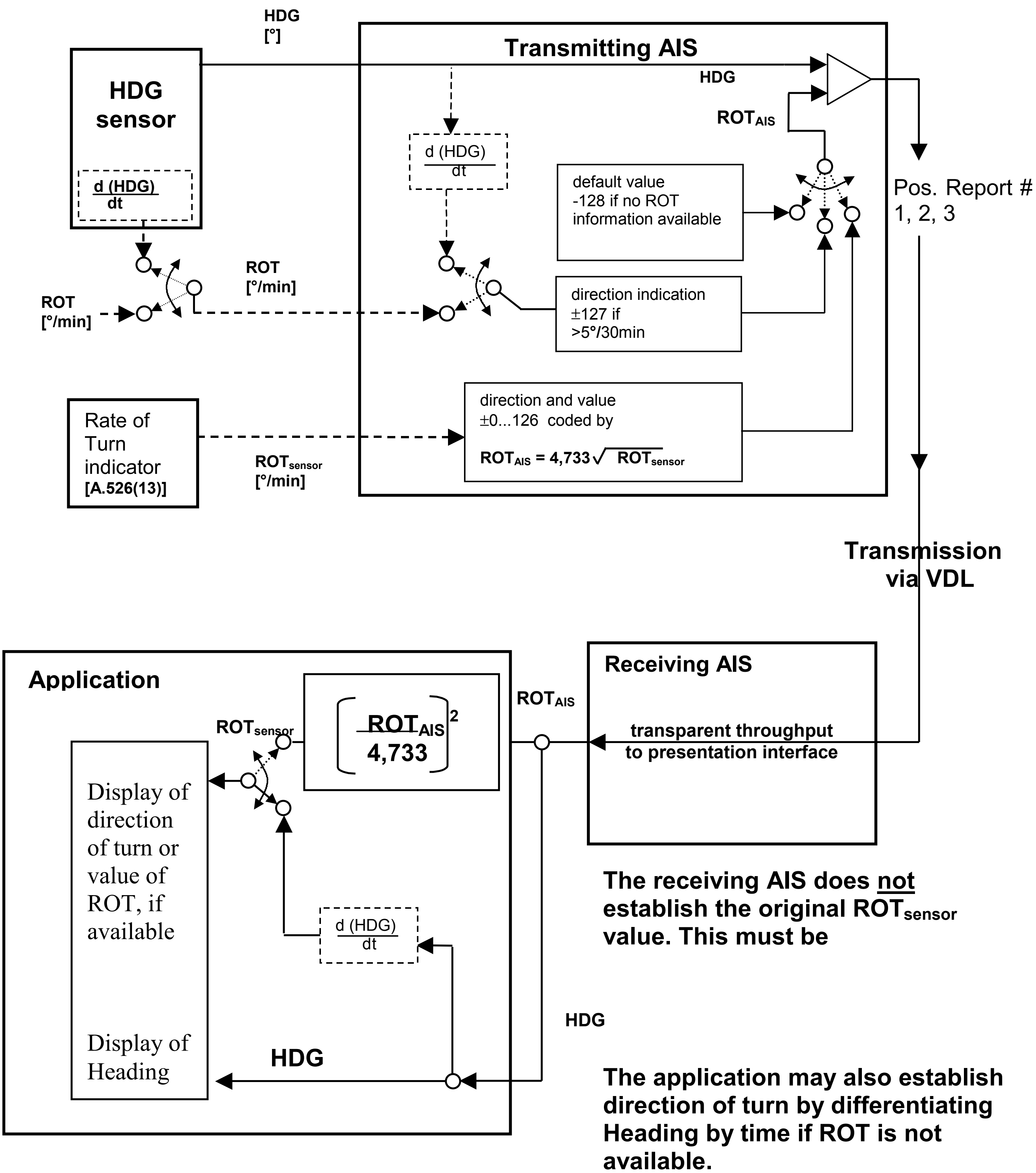
If a ship is not required to carry Turn-Indicator or if external sensor fails, the AIS should react according to following priorities:

Priority	Affected data in msg 1, 2, 3 ⇒ / Position Sensor status	Contents of ROT Field
1.	Rate of Turn Indicator in use [6]	0...+ 126 = turning right at up to 708 degrees per minute or higher; 0...- 126 = turning left at up to 708 degrees per minute or higher Values between 0 and 708 degrees/min should be coded by ROT_{AIS}=4.733 SQRT(ROT_{sensor}) degrees/min where ROT_{sensor} is the Rate of Turn as input by the external Rate of Turn Indicator (TI). Values of 709 degrees per minute and above should be limited to 708 degrees per minute.
2.	other ROT source in use [7]	+ 127 = turning right at more than 5^0/30s (No TI available) 0 no turn - 127 = turning Left at more than 5^0/30s (No TI available)
3.	no valid ROT information available	–128 (80 hex) indicates no turn information available (default)

Table 23: ROT Sensor Fallback Conditions

[6] Rate of Turn Indicator according to resolution A.526(13); determined by talker ID
[7] i.e. based on HDG information

Figure 10: Rate of Turn Sensor Input Overview



9 ANNEX B TYPE OF SHIP TABLE

Identifier No.	Special craft
50	Pilot vessel
51	Search and rescue vessels
52	Tugs
53	Port tenders
54	Vessels with anti-pollution facilities or equipment
55	Law enforcement vessels
56	Spare – for assignments to local vessels
57	Spare – for assignments to local vessels
58	Medical transports (as defined in the 1949 Geneva Conventions and Additional Protocols)
59	Ships according to Resolution No 18 (Mob-83)

Other ships			
First digit (*)	Second digit (*)	First digit (*)	Second digit (*)
1 - reserved for future use	0 – All ships of this type	-	0 – Fishing
2 – WIG	1 – Carrying DG, HS, or MP IMO hazard or pollutant category A	-	1 – Towing
3 - see right column	2 – Carrying DG, HS, or MP IMO hazard or pollutant category B	3 – Vessel	2 – Towing and length of the tow exceeds 200 m or breadth exceeds 25 m
4 – HSC	3 – Carrying DG, HS, or MP IMO hazard or pollutant category C	-	3 – Engaged in dredging or underwater operations
5 – see above	4 – Carrying DG, HS, or MP IMO hazard or pollutant category D	-	4 – Engaged in diving operations
	5 – reserved for future use	-	5 – Engaged in military operations
6 – Passenger ships	6 – reserved for future use	-	6 – Sailing
7 – Cargo ships	7 –reserved for future use	-	7 – Pleasure Craft
8 – Tanker(s)	8 – reserved for future use	-	8 – reserved for future use
9 – Other types of ship	9 – No additional information	-	9 – reserved for future use

DG: DangerousGoods.
HS: HarmfulSubstances.
MP: Marine Pollutants.

(*) NOTE – The identifier should be constructed by selecting the appropriate first and second digits.

Table 24: Identifiers to be used by ships to report their type

10 ANNEX C: RECOMMENDED IEC 61162 SENTENCES

To connect external sensors it is recommended to configure the following sentences as indicated below.

Data	IEC 61162-1 Sentence formatters	
	Preferred	Optional
Reference datum	DTM	
Positioning system: Time of position Latitude / Longitude Position accuracy	GNS GLL	GGA , RMC
Speed Over Ground (SOG)	VBW	VTG, OSD, RMC
Course Over Ground (COG)	RMC	VTG, OSD
Heading	HDT	OSD
RAIM indicator	GBS	
Rate Of Turn (ROT)	ROT	

Table 25: Preferred IEC 61162-1 Sensor Sentences

ANNEX 2: ABBREVIATIONS

4S	Ship to Ship and Ship to Shore
AIS	Automatic Identification System
AtoN	Aid to Navigation
ARPA	Automatic Radar Plotting Aid
ATA	Automatic Tracking Aid
AUSREP	Australian Ship Reporting System
BAS	Basic AIS Service
BIIT	Built in Integrity Test
BT	Bottom Track
COG	Course over Ground
COLREG	International Regulations for the Prevention of Collisions at Sea, 1972
CPA	Closest Point of Approach
DAC	Designated Area Code
DF	Direction Finding
DGNSS	Differential GNSS
DSC	Digital Selective Calling
EEZ	Exclusive Economic Zone
ECDIS	Electronic Chart Display and Information System
ECS	Electronic Charting System
EPA	Electronic Plotting Aid
EPFD	Electronic Position Fixing Device
ETA	Estimated Time of Arrival
FM/GMSK	Frequency Modulation / Gaussian Minimum Shift Keying
HDG	Heading
GLONASS	Global
GPS	Global Positioning System
GNSS	Global Navigational Satellite System
IAI	International application identifier
IALA	International Association of Marine Aids to Navigation and Lighthouse Authorities
IEC	International Electrotechnical Commission
IFI	International Function Identifier
IFM	International Function Message
IHO	International Hydrographic Organisation
IMO	International Maritime Organisation
INS	Integrated Navigation System
INMARSAT	International Maritime Satellite System
ITU	International Telecommunication Union
LR	Long Range
MID	Maritime Identification Digit
MKD	Minimum Keyboard and Display
MMSI	Maritime Mobile Service Identity
MSC	Maritime Safety Committee of IMO
MSG	Message
NAV	Sub-Committee for Navigation of IMO
NUC	Not Under Command

OOW	Officer of the Watch
PI	Presentation Interface
PPU	Portable Pilot Unit
RAI	Regional Application Identifier
REEFREP	Great Barrier Reef and Torres Strait Ship Reporting System
RF	Radio Frequency
RIATM	Restricted in Ability to Manoeuvre
ROT	Rate of Turn
Rx	Receiver
SAR	Search and Rescue
SME	Ship-borne Mobile Equipment
SOG	Speed over Ground
SOLAS	International Convention on the Safety of Life at Sea, 1974
SOTDMA	Self Organising Time Division Multiple Access
SRS	Ship Reporting System
SSD	Station Static Data (proposed)
TEZ	Tanker Exclusion Zone
TCPA	Time of Closest Point of Approach
TDMA	Time Division Multiple Access
THD	Transmitting Heading Device
TSS	Traffic Separation Scheme
Tx	Transmitter
UTC	Co-ordinated Universal Time (GMT)
VDL	VHF Data Link
VHF	Very High Frequency
VSD	Voyage Static Data (proposed)
VTS	Vessel Traffic Service
WG	Working Group
WGS 84	World Geodetic System 1984
WP	Way Point
WRC	World Radio Conference